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GRADUATE WORK IN MATHEMATICS IN UNIVERSITIES AND IN OTHER INSTITUTIONS OF LIKE GRADE IN THE UNITED STATES¹

I. THE ESTABLISHMENT OF ADVANCED INSTRUCTION IN THE UNITED STATES

FORTY years ago the bachelor's degree granted on the completion of a four years' course of a general character marked not merely the close of a young man's liberal education, but also, except in the case of some lawyers, ministers and physicians, the end of all academic instruction of any kind. In particular, apart from a few exceptional cases, no advanced instruction in mathematics was anywhere provided beyond the usually rather meager ingredients—hardly more than analytic geometry and a little calculus—of this college course, which consisted mainly of prescribed studies. As an external sign of this state of affairs we note that the master's degree, where it existed, was conferred for reasons having very little to do with study, while the doctor's degree was practically non-existent.² The desire for higher education in America, which had been felt for many years by some of the leading minds of the country, had been able so far to achieve only momentary and sporadic success.

¹ General report of the committee consisting of Professor Maxime Bôcher, Harvard University, Cambridge, Mass., chairman; Professor D. R. Curtiss, Northwestern University, Evanston, Ill.; Professor Percy F. Smith, Yale University, New Haven, Conn., and Professor E. B. Van Vleck, The University of Wisconsin, Madison, Wis. The report is Bulletin No. 6 (1911) of the United States Bureau of Education.

² Except at Yale University, where the degree of doctor of philosophy was established in 1860.

The most notable example of such a momentary success, so far as the study of mathematics is concerned, is to be found at Harvard during the fifties and early sixties, where, under the guidance of Benjamin Peirce, a band of young men devoted themselves successfully to the pursuit of higher mathematics.³ A few of these have since attained world-wide fame, while others were influential in introducing advanced mathematical instruction into the United States twenty or thirty years later. Peirce's success in collecting at this time a fair number of competent students for graduate work seems to have been due primarily to the presence of the office of the American Nautical Almanac at Cambridge from 1849 to 1866, and, secondarily, to the founding in 1847 of the Lawrence Scientific School,⁴ which, in those early years, possessed, under the leadership of Louis Agassiz, Jeffries Wyman, Asa Gray and others, some of the aspects of what is now known as a graduate school.

We notice, in passing, the contrast presented at this time, and for many years after, between the increasing supply of good astronomers in this country and the lack of men who, even by a stretch of the imagination, could be called mathemati-

³Peirce was tutor or professor of mathematics at Harvard from 1831 till his death in 1880, but, except during the period here considered, it was only in the last ten years of his life that, under the influence of an expanding elective system, he again began to have an appreciable number of advanced students.

⁴In the same year the department of philosophy and the arts was organized at Yale with the purpose of furnishing "resident graduates and others with the opportunity of devoting themselves to special branches of study," these branches embracing "theology, law, medicine and more particularly mathematical science and physical science and its applications." It was in this department that the doctor's degree was established in 1860, as noted above.

cians. It may fairly be said that the mathematical talent of the country was at this time diverted to astronomy.

Various circumstances united to bring a large measure of success in the establishment of graduate instruction in all fields, and in particular in mathematics, during the years 1870-1890. The great increase of wealth in the country brought with it endowments of many sorts which strengthened the older universities and established some important new seats of learning. Three things may be mentioned which, on this basis of material prosperity, did more than anything else to help forward the cause of graduate study in the critical period we are now considering.

1. *Study Abroad.*—For many years an occasional American had gone abroad to complete his studies. Thus B. A. Gould, a pupil of Benjamin Peirce and a graduate of the class of 1844 at Harvard, who later became eminent as an astronomer, studied with Gauss in Göttingen and took his doctor's degree there in 1848. Similarly J. Willard Gibbs after taking his doctor's degree at Yale in 1863 spent three years (1866-1869) in Paris, Berlin and Heidelberg, where he studied with Kirchhoff, Helmholtz, Weierstrass and others. A few more cases of a similar sort might be recorded, but it was not until the end of the seventies or the beginning of the eighties that the stream of mathematical students from America to Europe (generally to Germany) became a steady one. This tendency to go to Germany for the closing years of study contributed probably more than anything else to build up sound standards of productive scholarship and of graduate teaching, without which all attempts to establish advanced instruction in this country must have remained abortive. Its success was in part due to the establish-

ment and the wise administration of traveling fellowships, first at Harvard and then, to a much less degree, elsewhere. We shall return to this important matter of study abroad in a later section.

2. *The Foundation of Johns Hopkins University.*—The magnificent bequest of Johns Hopkins of \$3,500,000 for the foundation of a university in Baltimore, and his wisdom in leaving his board of trustees a free hand in the organization of the institution resulted in the adoption, on President Gilman's initiative, of a plan whereby the ordinary undergraduate instruction was relegated to a subordinate position from the very start, so that the new university stood before the American public as the standard bearer of the higher education. This was of inestimable benefit in strengthening the hands of those members of the faculties of the older universities who had been struggling to establish and develop graduate instruction at their own institutions. The presence of the eminent English mathematician, Sylvester, as professor of mathematics during the first seven years of the Johns Hopkins University had also a marked effect in stimulating interest in advanced mathematical studies in America, though it is easy to overestimate his direct influence, as he was a poor teacher with an imperfect knowledge of mathematical literature. He possessed, however, an extraordinary personality, and had in remarkable degree the gift of imparting enthusiasm, a quality of no small value in pioneer days such as these were with us.

3. *The Elective System.*—At the beginning of the period under consideration the lack of students qualified to undertake advanced work was most keenly felt and made any large success in the establishment of graduate instruction an impossibility. The adoption under the lead of

President Eliot, first at Harvard and then to a greater or less extent throughout the country, of a far-reaching elective system in the four-years' undergraduate course furnished a possibility for the gradual extension of instruction in the special fields. Without entering on the question of the advantages and disadvantages of the elective system for the college itself, we may safely say that it provided a basis for advanced instruction without which any considerable development of such instruction, at least during the years of which we are now speaking, would hardly be conceivable.⁵

At the close of the period we are considering, when the idea of graduate instruction had already taken a firm hold on many of the stronger institutions of the country, the founding of Clark University exclusively for graduate study in mathematics, psychology, biology, physics and chemistry gave a further impetus to specialization in advanced work, and the opening of the University of Chicago in 1892 may almost be said to mark an epoch in the development of graduate instruction in the west and middle west; for, though that university had from the start an undergraduate department, it stood out, through the character of its faculty and the emphasis laid on research work, as a strong exponent of the graduate idea.

While in these universities, as well as at

⁵ Cf., however, the closing remarks of section II. What we desire to emphasize here is that an elective system so arranged as to allow some specialization in individual departments, not merely the choice between various *elementary* subjects, permitted a gradual development of more and more advanced instruction, the students being at first mainly undergraduates. Such a development could go on simultaneously at many places, while even a single attempt to duplicate the Johns Hopkins experiment would probably have quickly led to disastrous failure.

Johns Hopkins, advanced instruction was at once placed in a department by itself, in by far the larger number of institutions it developed very gradually within the old college, room being made for it by the elective system; and it was only slowly, even in the larger institutions, that small groups of graduate students began to collect. The somewhat unorganized condition, which was then the rule, is still to be found in the weaker institutions of the country and also in some colleges which in their chosen field of undergraduate work are strong, but which voluntarily renounce any substantial development of graduate instruction. The great universities, however, have all, since the year 1890, developed well-organized graduate schools frequented by the graduates of their own and other colleges. It may be added, to avoid possible misconception, that the graduate schools which sprang full-fledged into existence and those which developed slowly from the old college no longer form two distinct classes. Some of the strongest graduate schools in the country are now to be found among the last-named institutions.

In contrast with such countries as France, Italy and, to a less extent, Germany, we note the complete lack of central control or organization in the United States. Many variations are hereby made possible which are, for a country like ours, almost a necessity; and competition, on the whole healthy, springs up between the different institutions.

In conclusion we note that of late years some technological schools (for instance the Massachusetts Institute of Technology) have undertaken a limited amount of graduate instruction in mathematics. As this instruction does not differ, except in the greater emphasis laid on applied math-

ematics, from that given at colleges and universities, and since the amount of such instruction at technological institutions is as yet very small in comparison to the whole amount of mathematical graduate instruction in the country, we have not thought it necessary to mention these technological schools specifically in what follows.

II. THE GRADUATE STUDENT OF MATHEMATICS AT THE PRESENT DAY

Owing to the great variety of standards for the bachelor's degree in the different colleges of the country, the students of a single graduate school enter it with very diverse preparation. This is, however, not so disturbing as might be expected, owing to the fact that at every university in which a graduate school exists there is a collegiate or undergraduate department whose instruction is freely open to the graduate student who is in need of it. We may then say that not all work done by graduate students is graduate work. On the other hand, the ambitious and capable senior in colleges allowing considerable freedom of election will frequently be doing work of a distinctly graduate character in the same classes with able graduates of colleges in good standing.

If we thus miss any sharp line of demarcation at the lower limit of the graduate school between graduates and undergraduates, we find a similar phenomenon at the upper limit where the graduate student often passes by almost imperceptible steps into the teacher. Indeed there are graduate schools, even among the better institutions of the country, the bulk of whose students are at the same time assistants or instructors. This, and the very high percentage of graduate students of mathematics the country over who are fel-

lowship and scholarship holders are features of American education which, it is to be hoped, will gradually pass away.* They are closely related to the presence in graduate schools of large numbers of students of mathematics who have reached an age when their students days should be over. It can not be too strongly urged on all who give young men advice or who are influential, by awarding scholarships or otherwise, in shaping their careers that it is only in his first youth (not at the age of thirty or thirty-five) that the foundation of real success can be laid by the student of mathematics.

A somewhat different class is formed by school teachers in active service who are at the same time enrolled as graduate students of mathematics, but at any moment take necessarily only a small amount of work. The ambition of these teachers to improve their professional equipment is most laudable. When, however, as is sometimes the case, they form a considerable proportion of the enrollment of a graduate school, they may be a source of weakness to that school in spite of their earnestness of purpose.

The period spent by a student in graduate study varies from one to three, or even more years; and the amount of migration from one university to another does not seem to be large, although the great majority of students attend a graduate school at a different university from that at which their undergraduate years were spent.

We note also that in graduate work coeducation is the almost universal rule, not only in the great state and other western institutions where coeducation forms an integral part of the scheme of education

* Nothing in any way resembling this free award of financial aid is found necessary to induce strong men to attend schools of law or engineering. Cf. the closing lines of this section.

from top to bottom, but even in the most conservative institutions of the east, which do not admit women to their undergraduate departments. Apart from Princeton and the University of Virginia, where no women are admitted, it is only in women's colleges (Bryn Mawr, Vassar, etc.) and in some institutions for men which have held firmly to the undergraduate idea, so that the amount of graduate work is very limited, that one sex alone will be found.

A striking and significant fact is that nearly half of all graduate students of mathematics come from small colleges. This is probably due to the fact that in such colleges students always have the opportunity to study the elements of mathematics and often something beyond the elements, while the inducements for them to turn away into other fields are slight in comparison to those offered at larger institutions where a richer elective system prevails. The tendency so strong in our day and country to regard the man of action as being of nobler clay than the man of thought and ideas, reinforced by the much greater financial prizes open to the former, whether he be lawyer, business man or engineer, creates a situation where it is not easy to secure for mathematical study a due proportion of the strongest youth in our college communities.

III. THE ORGANIZATION OF ADVANCED MATHEMATICAL INSTRUCTION[†]

The purpose of mathematical instruction should be fourfold:

- I. To impart knowledge.
- II. To develop power and individual initiative.
- III. To lead the student to express adequately and clearly what he knows.

[†] Cf. also the report of subcommittee 1.

IV. To awaken the love of knowledge and to impart scholarly ideals.

The first of these aims, without attention to which the other three can not be obtained, has led to the great development of the lecture system which we find in all graduate schools, and to the use of the textbook and treatise either in connection with these lecture courses or independently of them, and of the original memoir, the reading of which constitutes an art by no means easy to acquire, and which deserves special cultivation at the hands of the members of the teaching staff.

As means used under II. may be mentioned: First, the solution of problems by students either in connection with the lecture courses or in special seminars or pro-seminars, and secondly, the writing of theses which may or may not be connected with the doctor's degree. This last is also the chief means employed under III., although the quiz (cf. subcommittee 3, section IV.) is sometimes employed effectively for this purpose, and even the brief written problem is not without some value here.

Both II. and III, above should receive more attention than is now commonly given to them, while I. is at present adequately treated, except, perhaps in the relative weakness of applied as distinguished from pure mathematics.

The aim indicated under IV. depends for its attainment less on special methods of instruction and more on the personality of the instructor and his attitude towards science than do I., II. or III. To secure adequately the end in view, an instructor is needed who combines high *scientific* ideals with a commanding or sympathetic personality. Such men could do much to counteract the tendency noted in the closing lines of section II., but, on the other hand, it is precisely this tendency

which makes them difficult to secure. Their influence on undergraduate instruction should be no less valuable than in the graduate school.

We must come back once more to the lecture courses which everywhere form the backbone of graduate mathematical instruction. Such a course usually extends either through the whole academic year, that is, from the end of September till early in June, or through the first or second half of this year.* The lectures, of somewhat less than an hour each, come usually three times (less frequently twice) a week. While much depends on the local traditions and the personality of the instructor, it may in a general way be said that these lectures have a far less formal character than is the case in European universities. Students will frequently interrupt the lecturer with a question, and short discussions between the instructor and one or more students will not infrequently take place, and at times the more formal quiz (cf. subcommittee 1, section VI., and subcommittee 3, section IV.) finds its place here. Some tact and firmness are occasionally necessary to prevent the loquacious or thick-headed student from monopolizing the time of the class, but on the whole this frequent contact during the lecture between teacher and student is an admirable feature of American higher education, and counteracts, to a certain extent, some evils which usually accompany the lecture system. It is made possible by the smallness of the classes, an audience of twenty-five in a graduate course in mathematics being distinctly unusual.

The range of subjects covered by the courses offered in each graduate school is

* Attention must also be called to work in the summer schools and summer quarters. Cf. subcommittee 1, section IV.

very great (cf. subcommittee 1, section V.). This is peculiarly the case in those institutions which have only recently begun a policy of expansion in their graduate work, where the first sign of such expansion often appears in an astounding increase in the number and range of courses offered, for only a small part of which there are students. Indeed, if students should present themselves, the capacity of the teaching force would be completely overtaxed. This is a state of affairs which no self-respecting institution should allow to continue, and there are signs that it is usually of only a temporary nature, since with a real strengthening of the mathematical department of such an institution this inflation tends to disappear. We hasten to add that the stronger institutions, and many smaller institutions with a due sense of proportion, offer admirable selections of courses commensurate with their capacity and the needs of their students, courses which at each institution usually vary considerably from year to year. Even in the weaker institutions where a call for advanced instruction is hardly apparent, it may often be wise to encourage instructors to offer a course of a not wholly elementary character, as it will frequently be found to act as a tonic and, by keeping them in touch with the scientific side of their subject, enable them to make their elementary work more vital.

It was mentioned in section II. that no sharp distinction between graduate and undergraduate work in mathematics can be made. Indeed it is hard to exclude entirely from graduate work anything above the first course in the calculus, now commonly taken in the second undergraduate year. The actual state of affairs is best expressed by regarding the group of courses just following this point, such as a second

course in the calculus, the elements of determinants and of the theory of equations, projective geometry, a first course on differential equations, etc., as belonging both to graduate and to undergraduate instruction. From this latter point of view, however, these courses usually appeal only to the student of distinct mathematical ability and seriousness of purpose, whose presence in the course along with graduates does not very greatly affect the character of the course.

As the external signs of success for the graduate student we have the master's and the doctor's degrees. The first of these is commonly given for one year's graduate work done largely in one subject, such as mathematics or physics, and tested either by course examinations in which a higher standard is demanded than is accepted for undergraduates, or by a single examination covering the whole year's work. A thesis is also often required for the master's degree; but the work done on this thesis is not commonly of the nature of research work, and the degree is taken by considerable numbers of students most of whom never proceed further. This degree is given, and properly given, by a large number of institutions, many of which have only a very moderate strength in their graduate mathematical work. Under these conditions suggestions for a minimum standard for the degree are not out of place, and such suggestions will be found in the report of subcommittee 1, section VII.

The doctor's degree originally came to us from Germany, but has long been naturalized and is in all American institutions of good standing distinctly a research degree. In several of our stronger universities it has a standard at least as high as the best German standard. The requirements for the doctor's degree in universities which

have been given to any extent during the last ten years are tolerably uniform (cf. the report of subcommittee 2), but in this matter so much depends on the unwritten standards of individual professors or departments that there still remains a great difference in the ease with which the degree can be obtained at different institutions. It is for this reason that the suggestion which is sometimes made that it would be well to attempt to formulate definite standards for the doctor's degree, to which the universities of the country should conform, seems to be of slight practical value.

In school and college work America adopts in one respect a very different standpoint from France and Germany, and this has a certain indirect influence on graduate work. We refer here to the fact that in the last-named countries a pupil will not be allowed to proceed from class to class, and, particularly, will not be allowed to pass the great educational landmarks (for instance graduation from the gymnasium in Germany) without conforming to a very exacting standard which a considerable percentage of each class fails to attain. In America, on the other hand, the teacher who tries to impede seriously the progress of any but the unusually lazy or stupid soon makes himself impossible. This is not the place to discuss the respective merits of these two points of view in the secondary school or even in the college; but when we come to the graduate student of mathematics it seems clear that the American attitude must be modified, and, as a matter of fact, in all the stronger institutions of the country a much greater ability and earnestness of purpose is demanded for passing examinations and securing degrees in the graduate school than would be allowed to pass muster in undergraduate work. Nevertheless, it is to be

hoped that something more will be accomplished in this direction, and that, in particular, candidates for the doctor's degree will be made to feel that success for them at an institution of good standing is not a mere matter of time and patience. It is the more important to insist on this, since, as has just been said, the whole current of secondary and college education runs in another channel.

IV. TEACHERS

We must be concerned with this subject for two different reasons, first, because the great majority of graduate students of mathematics ultimately become teachers in secondary schools, colleges or universities; and, secondly, because on the quality and efficiency of the teachers in the graduate school itself (professors, instructors, etc.) depends to such a large degree the quality of the school.

It is a favorable sign of the gradual elevation of the profession of secondary-school teacher that of late years many persons wishing to adopt this profession spend a year in study in a graduate school. It is true that this time is frequently not spent in the study of a single subject; but for the future teacher of mathematics (or of mathematics and some other subject) to have had a couple of graduate courses in mathematics, usually in the intermediate group, is a very substantial gain over the conditions of twenty years ago. It is to this class of students that the courses on the teaching of mathematics, which are now given at many colleges and universities, mainly appeal.

If we except this group who go into secondary-school teaching, and a second group who study mathematics as a tool for use in some other science, such as physics, it may be said with almost absolute pre-

cision that all other students of mathematics in graduate schools become instructors in mathematics in colleges or universities. The condition of twenty-five years ago, where college instructors in mathematics were taken from among the freshly graduated students of a college (usually the same college where they were to teach), has now become the exception instead of the rule; and where it still occurs, the appointment is usually a temporary one, both the instructor and the college expecting that, after a year or two of teaching, further graduate study will follow. The gain involved in this changed state of affairs, both in breadth of view and in real mastery of the subject, the teaching of which is to be the young man's life work, is so obvious as to require no further comment here. If the student can furthermore be given some comprehension of the fact that the science of mathematics is a living and growing one through contact with other students or instructors who are themselves contributing to this growth, and still more if he himself can take some part in the development of mathematical knowledge, his outlook on mathematics in particular and intellectual life in general will have been so broadened that he can hardly fail to become a better member of a college faculty than would otherwise have been the case.

After all this has been said, we must, however, admit that this question has also another side less pleasant to contemplate. What passes for original research, in this country more even than abroad, is often hardly a real contribution to mathematical progress at all, but merely a grinding out of results, which if they have only never been published before may be as unimportant and unattractive as you please; they form an "original contribution." One is tempted to answer, Yes, in the same sense

as the brass button in the contribution box. We may feel certain that in the long run this will be the character of the research work done by students who have no real capacity or inclination for original work, but who are pushed into it by the increasing demand, on the part of certain heads of departments, for the doctor's degree as a necessary preliminary to college teaching. The pressure thus produced will surely, if persisted in, bring forth an increasing yearly crop of doctors—success can be obtained by almost any one with a fair mathematical capacity and with sufficient industry and patience, either by going abroad or by going to one of the weaker American institutions with an ambition for giving the doctor's degree. It is doubtful if the time will ever come, certainly it will not come for a great many years, when all the members of the teaching staffs of the large universities of the country, and the colleges of like rank, can be men with a real capacity for original investigation; the number of all such men in the country falls far short of (one might almost say that it is of a different order of magnitude from) the number of places to be filled.

The pseudo doctor, to whom reference was made above, is often narrowed rather than broadened by the bit of investigation which he has been set to do, and becomes thereby less effective as a teacher, investigation for him becoming a fetich for which he forgets all other ideals. Or, on the other hand, he may let all thought of original work drop out of his mind when once he has secured his degree. In either case the letters he places after his name ought not to go very far in recommending him for teaching positions. A broad and deep mathematical training should surely be demanded by all the institutions of the country which claim collegiate rank as a prerequisite for a permanent appointment on

their teaching staff. They will naturally demand also some ability as a teacher. If in addition they can secure an investigator of a genuine sort, even though his caliber be slight, they should usually regard themselves as fortunate, though a few of the strongest institutions can and should set themselves a much higher standard. On the other hand, our stronger graduate schools should continue, as they are now doing, to encourage every capable student to try his hand at some piece of original investigation, but they should not hesitate, after a fair trial, to tell him, if that turns out to be the case, that he is not fitted for that kind of work.

No specific training for the profession of college or university instructor is commonly given in graduate schools apart from the training in mathematics (cf. subcommittee 3, section V.). The statement made in section III. of the present report that the training in clear and adequate exposition which is given to graduate students of mathematics is frequently insufficient is of peculiar importance in relation to the future teacher. While it is probably not desirable to attempt to train the future college or university instructor in the art of teaching, the question whether more can not be done to lead graduate students of mathematics to express their ideas well both in spoken and in written form is worthy of serious consideration.

Let us turn now from the graduate students, who are to become college instructors, to the actual instructors and professors of mathematics in our colleges and universities. If we compare conditions at the present day with those existing twenty years ago, a very great increase in the standard of mathematical knowledge on the part of the teaching staff is evident. That the improvement here has not been

even greater is due in large measure to the fact that the supply of well-trained graduate students falls far short of the demand. Weak appointments are also made from time to time, owing to ignorance on the part of trustees or heads of departments of what really constitutes a mathematician, to the pernicious view that administrative ability may be allowed to take the place of mathematical ability, or to other like causes. Flagrant cases of this kind occasionally occur which make one blush for the good name of American universities, but such cases are now merely sporadic and one gains comfort by contemplating conditions in Germany only a hundred years ago. What is needed here, as in so many other places in American life, is a strengthening of *intelligent* idealism (we have more than enough misdirected idealism amongst us) based upon knowledge, and there seems every reason to hope that the great development of mathematics in this country during the last twenty years, evident chiefly in the growth and activity of the American Mathematical Society, will in an ever-increasing degree supply the intelligent and influential public opinion here needed. The shortage, above mentioned, in the supply of instructors in mathematics forms the most serious aspect of the situation.

For various further points: The excessive burdening of young instructors with drudgery, which still often occurs; inadequate salaries; the burdening of professors with administrative work; we refer to the report of subcommittee 3.

V. STUDY BY AMERICANS ABROAD

No account of higher mathematical education in America would be complete without a reference to the part played by the study of Americans abroad. What an im-

portant factor this was in introducing advanced mathematical instruction and research into America has already been mentioned in section I. In the early days the possibilities for advanced mathematical study in this country were very limited, so that it was natural that students able to do so should go abroad where they could find this opportunity in large measure. At the present day it may safely be said that at several of the stronger American graduate schools most American students find mathematical opportunities better suited to their needs than are to be found at any place abroad. Nevertheless, students still go abroad in apparently undiminished numbers to study mathematics,⁹ and their decision to do this is frequently a wise one. Let us inquire how this can be the case.

There come first considerations of a

⁹ It would be a matter of considerable interest to have statistics on the number of American students who go abroad each year to study mathematics and the length of time they stay. Such statistics would seem to be very difficult if not impossible to secure. As to the proportion of instructors of graduate courses in mathematics who have spent at least one year abroad, see the report of subcommittee 1, section III. Far less important is the question of the number of doctors' degrees conferred on Americans abroad. Such information might be secured. We content ourselves with giving two such items, for which we are indebted to Dr. Dunham Jackson:

At Göttingen in the years 1889-1909, inclusive, twenty-two Americans received the degree in mathematics, while no degrees in mathematics had been conferred on Americans during the four previous years.

At Leipzig in the years 1885-1902, inclusive, eight Americans received the degree in mathematics, while after this time Americans seem to have ceased taking the degree in mathematics there.

At present from two to four Americans take their degree in mathematics in Germany each year, as against an average of sixteen or seventeen in the United States.

nonmathematical character. It is desirable for every one to become acquainted at first hand with other countries than his own, and this is doubly true for an American, for whom a period of residence in European countries is invaluable. It is true that the student often seems to have brought back from a year or two of residence abroad only a strengthening of his earlier national prejudices, since the mote in the neighbor's eye is so very easy to discern;¹⁰ but if he is worth his salt, he brings with him a fund of impressions and experiences which, as time goes on, greatly enrich his life. For this reason alone study abroad is to be recommended even at some mathematical sacrifice. A second consideration is that the cost of living in Germany, to which country the great majority of students going abroad have always resorted, even after the great increase of the last few years, is still lower than in America, and in particular, the tuition fees are much less than in many of the larger American institutions, especially of the east. These facts largely counterbalance the expense of the trip across the ocean. Finally, it is to be remembered that a year or two of mathematical study in Germany, France or Italy gives the student a reading and speaking knowledge of one of the great languages of modern thought, besides his own native English, such as can hardly be acquired in any other way.

When we come to mathematical considerations, the first question we must ask is whether getting a degree or learning mathematics is the prime object of the student going abroad. It is the former which,

¹⁰ There are also cases in which he takes so kindly to foreign conditions as to become out of touch with America. It is, however, rare that this state of affairs should survive his return more than a few months.

owing to circumstances mentioned in section IV., is too often uppermost in his mind. A student of this category had much better go abroad for his degree than to a second-rate American institution. Of course some care must be exercised by him in the choice of his university, or he must have good fortune in writing a thesis whose weak points are not evident on a superficial examination, but his task is, on the whole, not a difficult one, and he gets at least the advantage of a period of foreign residence.

For another class of men foreign study may be recommended without qualification, namely, for able students who have already had a substantial training in one of the better American graduate schools, or who have even taken the doctor's degree at such a school. Such men will naturally go either to one of the great mathematical centers like Paris or Göttingen, where they will have the opportunity to hear lectures by several of the leading mathematicians of the day, and, perhaps, to see some of them occasionally outside of the lecture room; or they will select some mathematician of eminence in a particular field with whom they may hope to gain direct personal contact, and go to the university where he happens to be. Thus of late years a small but steady stream of American students has gone to Italy.

To the students just considered, and to some extent to their weaker comrades mentioned above, the period of residence at a great European mathematical center or of contact with an eminent mathematician at a less important European institution brings with it a realization of what high scientific ideals in mathematics are, and to what an extent they prevail abroad. Such ideals prevail also, it is true, at the strongest American institutions; but it is hard for the young American to appreciate their

great diffusion in a ripened civilization until he has experienced it by personal contact.

*ADDRESS AT THE UNVEILING OF THE
BUST OF WOLCOTT GIBBS IN RUM-
FORD HALL, CHEMISTS' CLUB,
NOVEMBER 25, 1911*

BECAUSE of the place of his birth and that where he was educated; because of the profession he chose and which he so highly adorned; because during the greater part of his mature life he applied his splendid talents and broad attainments to the realization of the hopes of the founder of the Royal Institution in his bequests to Harvard College and to the American Academy of Arts and Sciences; and because he was an academician and a club man, it is eminently fitting that the bust of Wolcott Gibbs should be unveiled in the Rumford Hall of the Chemists' Club of the City of New York.

For on February 21, 1822, he was born in this city of New York; in 1841 he received his baccalaureate degree from Columbia College of this city; in 1845 he received the degree of M.D. from the College of Physicians and Surgeons of this city; he chose chemistry as his profession; he was Rumford Professor of Harvard College and Harvard University for forty-five years and a member of the Rumford Committee of the American Academy of Arts and Sciences for thirty years; he was founder, member and president of the National Academy of Sciences; he suggested and organized the Union League Club of New York and he promoted and supported other social organizations.

His education was, however, much broader and more comprehensive than that comprised in his satisfaction of the requirements for the degrees awarded him at Columbia College and the College of Physicians and Surgeons, for in the interim between his graduation from the first named institution and his entrance on the second he served as laboratory assistant to Dr. Robert Hare, professor of chemistry in the University of Pennsylvania, then the most

eminent chemist America had produced and to-day revered for his splendid contributions to science. On his graduation from the College of Physicians and Surgeons, Gibbs went to Europe, where, until 1848, he continued his studies under the direction of the eminent chemists, Rammelsberg, Heinrich Rose, Liebig, Laurent, Dumas and Regnault, whose names are each inscribed upon the honor roll of those to whom the chemistry of to-day owes its place among the sciences.

Broadened by travel, by contact with these eminent investigators, and the students that gathered about them, Gibbs returned to his native country for service in his profession, and found his first opportunity in the delivery of a short course of lectures in a minor institution in Delaware, but very shortly after, in 1849, he was appointed professor of chemistry in the Free Academy, now the College of the City of New York, where he remained until 1863, when he accepted the Rumford professorship, requiring service in chemistry, in the scientific school of Harvard College.

His term of service in New York was distinguished, for, while his duty to the college demanded only that he teach its students the elements of chemistry, he began in 1851 as associate editor of the *American Journal of Science*, the preparation of abstracts of foreign literature in chemistry, and he engaged in research, with the result that in 1857 there was given to the world the first memoir on a notable and systematic research in chemistry from America, when the Smithsonian Institution published the memoir of Gibbs and Genth on "The Ammonio-Cobalt Bases," which has ever since served as a model for the presentation of results by investigators in chemistry. In 1861 his independent paper on the platinum metals appeared and, as Clarke says, "firmly established his reputation."

Gibbs was in New York when our Civil War came on and, devoted as he was to his profession, he was also a patriot. It will be recalled that in broadly fitting himself for his profession he had at the College of Physicians and Surgeons pursued that branch of Applied

Chemistry styled medicine and qualified in it, hence he could serve his country best and most by the exercise of his special knowledge and attainments. When men are rushing to expose themselves as targets for the enemy it requires a high degree of courage to offer on the altar of one's country one's special talents in service outside the firing line. But this Gibbs did and the U. S. Sanitary Commission stands to-day as an epoch in the civilization of man. By its work it proved, perhaps, to be the greatest good for mankind that was realized from that dreadful period of labor in which a great nation was born. It has been a model for other nations that have subsequently, unfortunately, been engaged in war.

Not content with applying his acquired knowledge, especially in that branch of applied chemistry known as medicine, to the amelioration of the "horrors of war" and to the aid of those that conquered, Gibbs sought to organize and crystallize opinion and effort by bringing together those of influence in New York who favored active military operations against the seceders and thus the Union League Club, which met, to organize, in his home, was formed. And throughout his life he was an organizer, or member, of bodies of men through which, by investigation, consideration and discussion, issues of moment in science were carefully wrought out, while social relations were conserved and promoted.

He was born and reared under conditions that could have bred an aristocrat. His father was in affluent circumstances. His progenitors had served their country and mankind in positions of importance. He inherited a competency. His associations from earliest youth were with the cultivated, intellectual and forceful. He was in person impressive and engaging. He was in taste and dress discriminating; but he was in his dealings with and estimates of man democratic.

As a prospective student I met him in 1868 and he looked to me god-like. It was my good fortune not only to be received as a student by him, but later to become his assistant and, through other fortunate circumstances,

such as being ordered to duty in Newport, where he resided after his retirement, to keep in contact with him quite up to the time of his death. I recall most vividly my first meeting with him, for he embodied in the flesh all that I had ever imagined of man, and though my relations with him were afterward quite close this feeling and belief persisted and remains. He was above the average man in height, and his body was symmetrically developed with his stature so that he walked and moved with natural gracefulness. His head was admirably proportioned and was covered with a splendid mass of curling black hair which matched the beard that covered his face. In clothing and person he was always decently fastidious, but ever the attracting features were his eyes, which were deep brown in color, lustrous and luminous; and his voice, which was full and rich, with a deliciously attractive and convincing overtone.

He gave the impression of mildness and fairness and continued association confirmed this first impression. Never have I met one who so avoided definitely judging his fellow-man or who when forced to do so judged him more fairly and without prejudice, for his mind was filled with the contemplation of nature in a large way and of its processes, and he was endeavoring constantly to comprehend them and to record the results of his observations and tests for the benefit and use of mankind. He regarded his fellow man in the same broad and tolerant manner. In fact the definite impression of him which one received by close contact with him was largeness of vision; breadth of view; tolerance of differences in opinions, methods or manners; and sympathy, in a broad way, for mankind; and that he approached every issue, scientific or social, without prejudice, and with an entirely open mind.

If, in my attempt to portray Dr. Wolcott Gibbs from the image that abides with me, I have conveyed to you the impression that, through timidity or indolence he sought to avoid strife, let me hasten to immediately correct this erroneous impression, for on the con-

trary he was intensely human and he met his troubles in a thoroughly human way, but even then on a high plane.

Permit me to illustrate by an anecdote or two. Self-government by students is regarded in this country as a very modern and novel development. Dr. Gibbs introduced it at the outset of his coming to Cambridge. I do not know that he had not previously done so in the College of the City of New York. Eventually in my career as a student in his laboratory I succeeded to the first place in the governing body and I wore the resounding title of chief of police. During my administration a rebellion arose. The orders I gave were not obeyed and the fines I assessed were not paid. Having exhausted all the resources of authority at my command and the disorder having become a menace to all earnest students, after due warning, I resorted to the unheard-of expedient of reporting the recalcitrants to Dr. Gibbs. They were much amused when they were directed to report to this mild-mannered, sweet-tempered gentleman. I was not present at the interview. I never knew what occurred at that interview. The students never told me and Dr. Gibbs never referred to it. But what I do know is that when these students returned they said, "Munroe, you may order us to do what you wish; you may assess such fines as you please; but never again direct us to report to Dr. Gibbs," and from that day until I left the laboratory discipline was complete.

Strange as it may seem Dr. Gibbs became, on coming to Harvard, a storm center. President Hill called him because he had a vacant chair in chemistry to fill and he found in Gibbs the most eminent chemist in America. Gibbs accepted the position at Harvard because it seemed to offer the largest opportunity for usefulness in the field for which he was especially equipped. But his appointment thwarted the realization of the ambitions of others; it became a cause of dissension and the arraying of groups of men against each other. The situation had become acute as I entered upon the scene. In the

regular performance of my duties I was unwittingly forced to know of it, though then I knew not the reason for it or the extent of it. I was especially embarrassed to come upon Professors Gibbs and Cooke, when they were engaged in a gentlemanly, but very personal, altercation.

Unknowingly to me, out of this came my opportunity. While holding the position of private assistant to Dr. Gibbs I was appointed assistant in chemistry in the college under Professor Cooke. With the courtesy that prevails among gentlemen all these arrangements were ostensibly in the hands of Dr. Gibbs and it was from him that I received my instructions to make that visit to President Eliot at which I received notification of my appointment to the college. Naturally and most properly I reported to Dr. Gibbs that I had obeyed his instructions, and the results of so doing, and I can never forget his admonition. Knowing my loyalty to him, knowing that inadvertently I had become somewhat acquainted with the distressing situation, he said, "Mr. Munroe I have been deposed and you are appointed to take my place. You know that my relations with Professor Cooke have not been entirely amicable, yet let me say that you can serve me best by serving him with entire devotion." Thus spoke the man in Wolcott Gibbs.

Were there time I should like to describe the laboratory at the Lawrence Scientific School and the manner in which it was directed by Dr. Gibbs. Fortunately this has been well recorded by Professor F. W. Clarke in his memorial lecture before the Chemical Society of Great Britain and by Stephen Paschall Sharples in his description of the Lawrence Scientific School to the Cambridge Historical Society. I may say that were it to be investigated by an agent of the Carnegie Foundation, armed with a pad and pencil, it must have been condemned. I must further say that after completing my fortieth consecutive year of university teaching I should, if put under oath, state that, measured by pedagogical standards, it was unsound.

But I must add that the results produced were splendid and that the students that survived the process went forth finely equipped to pursue their chosen professions. Dr. Gibbs's visits to us were infrequent, but the impression he made in these conferences were such that he was an ever-living presence and a constantly present example. Mendenhall's remark that a student would prefer to be neglected by Rowland to being taught by another embodies the thought I desire to convey concerning the relation of Wolcott Gibbs as a teacher to his students. The pedagogue trains his pupils as the military sergeant drills the cowherd. But the educator educes from his student his best capacities in the line of his endeavor. He brings the within without. He reveals to the student the latter's own capacities. He preserves to the community that precious gift, individuality, but arouses, and enlivens, and controls it so that it may best serve the community in which that individual may be placed. It is impossible to formulate the manner in which this may be accomplished, for the possibilities vary with each student to be taught and with him who teaches, and the teachers who comprehend this are rare, but such was Wolcott Gibbs.

It is said of Gibbs that he was not a "popular lecturer." I may say that this was most unfortunate for the populace. It has been my privilege to listen to a large number of those public speakers who have commended themselves to the public. As a youth I reported at length, for the newspapers, the lectures of Tyndall and Proctor. I served as demonstrator for Professor Cooke in that charming course of lectures at the Lowell Institute which appeared as "The New Chemistry." I sat at the feet of Edward Everett, Henry Ward Beecher, Wendell Phillips and Emerson. I was enthralled by Julia Ward Howe and Mary A. Livermore. Dr. Gibbs gave us but few lectures, but those were enriched by such a wealth of knowledge, graced with such diction, planned in so thoroughly logical and systematic a manner and presented with such

charming simplicity as to ever remain as almost unapproachable models.

For Dr. Gibbs was ever true to his best capacity (his proper sphere of usefulness to his fellows), namely, research, and he continued this long after his retirement from the field of teaching. As one reviews his achievements in research one is amazed at the catholicity of his accomplishments. All recognize his numerous contributions to analytical chemistry, his application of the electric current to quantitative determinations being especially well known; but he covered the field from gravimetric, through volumetric, to gas analysis. It is also pretty generally known that his early investigations of the complex ammonium bases, and their compounds, were in his later life supplemented by researches into the constitutions of the complex inorganic acids. Organic chemistry claimed his attention. In 1853 he prepared an arsenical derivative of valeric acid. In 1868 he discussed the constitution of uric acid and its derivatives. In 1869 he described some products formed by the action of alkali nitrites upon them. In 1891 and 1892, with H. A. Hare and E. T. Reichert, he treated of the physiological action of definitely related chemical compounds. He produced memoirs on a normal map of the solar spectrum and on the wave-lengths of the elementary spectral lines, and, in the study of interference phenomena, he discovered a constant, which he styled the interferential constant. The time allotted me is too brief to enable me to set forth the work of an investigator who at the age of eighteen published a paper entitled a "Description of a New Form of Magneto-electric Machine, and an Account of a Carbon Battery of Considerable Energy" and at seventy-one years of age published a method for the separation of the rare earths, further than to say that while Gibbs was an experimentalist rather than a theorist he published views on theoretical chemistry that have force to-day.

By virtue of his sympathy and breadth he became a pioneer in comprehending, assimilating and expounding the results of others,

giving them always full credit. He was the first American to adopt and promulgate the conclusions of Cannizzario; so early as 1880 he appreciated the value of the researches of J. Willard Gibbs and was the prime factor in having the Rumford medal conferred on this immortal Yale physicist. I well remember his enthusiasm in those early days when speaking of the recently published, and now classic, memoir of Kekulé.

I fear the privilege you have afforded me to speak of my beloved master has tempted me to overstay the time allotted me and yet I feel I have but inadequately set forth the man and his achievements. In closing permit me to quote from the admirable tribute paid him by Theodore W. Richards:

The circumstances of his early academic life brought him in contact with but few students. This is the more to be regretted because of his enthusiastic spirit, his tireless energy, his recognition of everything good, and best of all his warm human friendship which endeared him to all who knew him. Those who were thus fortunate, whether students or colleagues, will always devotedly treasure his memory; and his place as a pioneer in science in America will always be secure.

CHARLES E. MUNROE

SCIENTIFIC NOTES AND NEWS

ALEXANDER C. HUMPHREYS, president of Stevens Institute of Technology, has been elected president of the American Society of Mechanical Engineers.

MR. EMERSON McMILLIN has been elected president of the New York Academy of Sciences. The vice-presidents for the sections are: Professor J. Edmund Woodman, Professor Charles Lane Poor, Dr. Frederic A. Lucas and Professor R. S. Woodworth.

THE colleagues, friends and pupils of Professor Armand Gautier, professor of chemistry at the Medical Faculty of the University of Paris and president of the Academy of Sciences, on November 26, celebrated the fiftieth anniversary of his connection with the university.

MR. W. BATESON, M.D., F.R.S., has been appointed Fullerian professor of physiology at

the Royal Institution, for a term of three years.

THE following have been appointed special lecturers on economic geology at McGill University, for the year 1912: Dr. W. Lindgren, United States Geological Survey; Dr. E. Haanel, Department of Mines, Ottawa; J. A. Dresser, Esq., M.A., the Canada Iron Corporation, Sault Ste. Marie.

DR. V. A. MOORE, director of the State Veterinary College, Cornell University, has been elected foreign correspondent of the Central Society of Veterinary Medicine of Paris.

As corresponding members of the Munich Academy of Sciences, there have been elected Dr. Bauschinger, professor of astronomy at Strasburg; Dr. Planck, professor of theoretical physics at Berlin; Dr. von Kries, professor of physiology at Freiburg; Dr. Roux, professor of anatomy at Halle, and Dr. Wiechert, professor of geophysics at Göttingen.

THE organizing committee for the Imperial University Congress to be held in London next July, have appointed Dr. Alexander Hill, M.D., to be secretary to the congress, in the place of the late Dr. R. D. Roberts. Dr. Hill was formerly master of Downing College, Cambridge.

THE special board for biology and geology at Cambridge University has adjudged the Walsingham Medal for 1911 to Mr. R. H. Compton, Gonville and Caius, for his essay entitled "An Investigation of the Seedling Structure in Leguminosæ"; and a second Walsingham Medal to Mr. Walter Stiles, Emmanuel, for his essay entitled "On the Podocarpeæ."

PROFESSOR ROBERT ORTON MOODY, of the department of anatomy of the University of California, is spending a sabbatic leave of absence in Europe.

MR. W. H. LONG, recently of the editorial staff of the *Experiment Station Record*, has accepted a position as forest pathologist in the Bureau of Plant Industry. He will have charge of the work in forest pathology in National Forest District 3, which comprises the

national forests in the states of Arizona, New Mexico, Oklahoma, Arkansas and Florida.

MR. A. F. VASS has been appointed and has assumed his duties as assistant bacteriologist at the Oregon Agricultural College and Experiment Station. Mr. Vass is a graduate of the Kansas State Agricultural College and received his master's degree from the University of Wisconsin in soil bacteriology.

DR. ALFRED IRVING LUDLOW, a graduate of Adelbert College and of the medical department of Western Reserve University, professor of general pathology in the Dental School of Western Reserve University, and demonstrator of surgery in the medical department, and Mrs. Ludlow, sailed on December 19, for Seoul, Korea, to engage in medical educational work. He will be one of those in charge of the Severance Hospital and Medical College. The new building of the Medical College will be completed the first of the year and will furnish accommodations for a hundred students.

ACCORDING to a dispatch from St. Petersburg to the daily papers the Russian ban against the order of the Jesuits has proved a bar against the entry into that country of Father Pigot, who is particularly anxious to visit the Pulkova Observatory, in order to investigate seismological questions with Prince Galitzine. The British embassy, on behalf of the meteorological office in London, made special representations at the ministry of the interior, asking that the anti-Jesuit law might be relaxed, but all efforts have been unavailing.

DR. E. G. COOLEY, who as a representative of the Commercial Club of Chicago has recently visited Germany and has made an exhaustive study of conditions of vocational education in that country, has given a series of lectures at the University of Illinois on "Vocational Education in Germany." In addition to his regular lectures he held an informal conference with the faculty of the College of Engineering.

MR. R. J. YOUNG, of the North Chicago Works of the Illinois Steel Company, who is a member of the committee on safety devices

of the United States Steel Corporation, gave a lecture before the students and faculty of the College of Engineering of the University of Illinois on December 13, in which he described a large number of devices for protecting workmen against accident in steel mills. His lecture was profusely illustrated with lantern slides of devices in actual use.

THE Linacre lecture at St. John's College, Cambridge, will be delivered by Sir Ronald Ross on January 19, on "Recent Work on Malaria."

EXERCISES were held at the Presbyterian Hospital, New York, on December 2, in celebration of the forty-third anniversary of the hospital. Dr. William H. Welch, of the Johns Hopkins University, delivered an address commendatory of the recent affiliation of the Presbyterian Hospital with the College of Physicians and Surgeons of Columbia University.

As we learn from the *Journal* of the American Medical Association, the appeal for the erection of a monument to Robert Koch has now been issued. As announced, the honorary presidency of the committee has been taken by the imperial chancellor while the acting president is the new chief of the state medical department, Professor Kirchner. To the committee belong, in addition to most of the members of the Prussian cabinet and the cabinets of the other states of the empire, the mayor of Berlin and the mayors of a large number of other cities, the most distinguished pupils of Koch and other notable persons. It is expected that the city of Berlin, of which Robert Koch was an honorary citizen, will contribute a large sum and furnish a place for the statue free of charge. On the part of the committee it is purposed to place the memorial on the Luisenplatz in front of the Kaiserin Friedrich-Haus for post-graduate instruction.

M. HENRI MONOD, former director of the public charities and hygiene in the French ministry of the interior and member of the Académie de médecine, has died, aged sixty-eight years.

DR. WALDEMAR DE LONGUINE, professor of chemistry at the University of Moscow, has died at the age of seventy-seven years.

THE American Society of Naturalists will, as already announced, meet at Princeton on December 28. In the morning the annual discussion will be on "The Relation of the Experimental Study of Genetics to the Problems of Evolution." The speakers will be: E. G. Conklin, Princeton University, "The Problems of Evolution and the Ways they May be Best Attacked"; C. B. Davenport, Carnegie Institution, "Light thrown by the Experimental Study of Heredity upon the Factors and Methods of Evolution"; W. Johannsen, University of Copenhagen, "Modern Exact Genetics in relation to the Problems of Evolution"; H. F. Osborn, American Museum of Natural History, "Unit Characters, Continuity and Discontinuity, as observed by the Paleontologist"; H. L. Clark, Museum of Comparative Zoology, Harvard University, "Pure Lines and Phylogeny." In the afternoon there will be a program of contributions to genetics. In the evening Dr. H. S. Jennings will give the presidential address on "Heredity and Personality."

THE thirteenth annual convention of the Society of Sigma Xi will be held at Washington in affiliation with the American Association for the Advancement of Science. The council will meet on Wednesday, December 27, at 3:30 P.M. The convention will meet on Thursday at 3:30 P.M. at St. John's Parish Hall, on Sixteenth Street near H Street. The dinner will be held the same evening at 6:30, at the Tea-cup Inn, which is near by. Delegates and other members wishing to participate in this dinner will sign their names to a list for this purpose at the registration desk of the American Association for the Advancement of Science, where the list will be found for signatures until noon on Thursday. All members who sign will be welcome to the dinner, where reports of progress of chapters will be made. The business to be transacted will require an unusually long session. After din-

ner, business will be resumed and proceed until finished.

A LADIES' COMMITTEE for the coming Washington meeting of the American Association for the Advancement of Science and the affiliated and other societies meeting at the same time has been formed, with Mrs. Robert S. Woodward as chairman. Aside from the general functions, which will include a reception following the address of President Taft in the new National Museum on Wednesday evening, December 27, a reception at the Corcoran Art Gallery on Thursday night, December 28, by invitation of the trustees of the gallery, and an exhibition cavalry drill at Fort Myer, Virginia, on Thursday afternoon, the committee has arranged for a reception and tea at the Carnegie Institution of Washington on Wednesday afternoon at the invitation of Dr. and Mrs. R. S. Woodward. A tea to the visiting women will be given at the Cornell Women's Club of Washington at the residence of Mrs. Frederick A. Holton, 2125 S Street, Northwest, on Thursday afternoon. It is hoped that a tea can be arranged for Friday at the Washington Club. Professor and Mrs. Edgar Frisby will be at home to the members of the Astronomical and Astrophysical Society and accompanying ladies on Friday evening from 8 to 10 o'clock.

A FEW years ago, the American Association for the Advancement of Science decided to permit libraries desiring back numbers of sets of the American Association for the Advancement of Science *Proceedings* to have them up to a certain number on the condition of the payment of carriage charges by the receiving library. An announcement to this effect was published in *SCIENCE* at the time and a number of institutions responded. During the removal of the office in Washington, however, the list was unfortunately lost. Libraries which responded to the former request are urged to notify the permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C., especially stating that they are willing to pay the freight or express charges. The publications will then be sent.

Other libraries desiring the *Proceedings* on these conditions are invited to notify the permanent secretary.

THE readers of *SCIENCE* will probably recall the obituary notice of Miss Matilda H. Smith published in the issue of *SCIENCE* for August 5, 1910, in which mention was made of the benefactions of the deceased and her sister, Miss Jennie M. Smith, to the American Association for the Advancement of Science by occasional payments of life membership fees for worthy scientific men of relatively small means. The permanent secretary has received word of the death of the sister, Miss Jennie M. Smith, and a copy of her will in which it is requested that the sum of \$5,000 should be given to the American Association for the Advancement of Science, the said sum to be invested and the net income to be devoted to the creation of new life memberships in the Association. Under the terms of the will, similar bequests are made to the National Geographic Society of Washington and to the American Forestry Association of Washington. Other items in this will which are of interest to scientific men are as follows: \$10,000 to the University of Pittsburgh, the income of which is to be used in the purchase of books and mineral specimens and the enlargement generally of the collection in the university known as "Smith's Collections." \$10,000 to the Allegheny Observatory. \$5,000 to the School of Liberal Arts and Sciences, the same to be invested and the net income to be devoted to the support of scholarships to be known as the Matilda H. and the Jane M. Smith Scholarships. \$10,000 to the Allegheny General Hospital. \$10,000 to the West Penn Hospital. The remainder of the estate is divided among her relatives and church and philanthropical organizations.

As has already been noted here an institution for furthering the progress of scientific chemistry without the obligation of teaching is to be founded at Dahlem near Berlin. The institute is to be erected jointly by a society consisting principally of proprietors of chemical factories and the state of Prussia. The

society guarantees a yearly contribution of \$15,000 and for the building \$225,000. The government gives the ground and promises to furnish one of the professors of the university as the director of the institution. The management of the new imperial institute is to be in the hands of a committee.

THE Rockefeller Institute for Medical Research, which owns all the property from Sixty-fourth to Sixty-seventh Street and from Avenue A to Exterior Street has secured from the city the title to Sixty-fifth and Sixty-sixth Streets from Avenue A to Exterior Street. While these streets have been laid out, they have never been cut through.

THE legislature of Pennsylvania last year appropriated \$3,000,000 for its public health, \$2,000,000 of which was to be expended in the fight against tuberculosis, and \$1,000,000 to combat other diseases. The *Medical Record* states that during the past four years the number of deaths per annum has been decreased 14,000. It is estimated that about 2,500 deaths from typhoid fever and 7,000 from diphtheria were prevented last year by the activities of the State Health Department. The state maintains three sanatoria and 115 dispensaries for the treatment of tuberculosis and during the past year treated 40,000 cases of that disease. Taking the lowest estimated value of a human life, \$1,700, it is calculated that the economic saving to the state through this reduction of the death rate amounts to \$24,000,000 for the year. Preliminary arrangements have been made for the medical inspection of girls and boys in the third and fourth class school districts throughout the state. Five hundred physicians will be appointed to the task which embraces the examination of children in 321 boroughs and 460 townships.

THE following are the lecture arrangements at the Royal Institution before Easter: Dr. P. Chalmers Mitchell, a Christmas course of six illustrated lectures on the "Childhood of Animals," adapted to a juvenile auditory; Mr. W. Bateson, Fullerian professor of physiology, six lectures on the "Study of Genet-

ics"; Professor E. G. Coker, two lectures on "Optical Determination of Stress and some Applications to Engineering Problems"; Dr. T. Rice Holmes, three lectures on "Ancient Britain"; Professor A. W. Bickerton, two lectures on the "New Astronomy"; Professor A. M. Worthington, two experimentally illustrated lectures on the "Phenomena of Splashes"; Mr. M. H. Spielmann, two lectures on the "Portraiture of Shakespeare"; Mr. F. A. Dixey, two lectures on "Dimorphism in Butterflies"; the Rev. John Roscoe, two lectures on the "Banyoro: A Pastoral People of Uganda"; Professor Sir J. J. Thomson, professor of natural philosophy, six lectures on "Molecular Physics." The Friday evening meetings will begin on January 19, when Professor Sir James Dewar will deliver a discourse on "Heat Problems."

UNIVERSITY AND EDUCATIONAL NEWS

By the terms of the will of Mrs. Jan K. Sacher, who died in Oakland recently, the University of California is to receive \$500,000. The will stipulates that \$200,000 is to be spent on a granite campanile tower, 300 feet in height, to be erected in the center of the university grounds.

A HALF-MILLION endowment has been secured by Huron College, a Presbyterian institution in Huron, S. D.

ST. LAWRENCE UNIVERSITY has obtained a \$200,000 endowment fund, of which the General Education Board has contributed \$50,000.

A DEPARTMENT of veterinary science has been established at the University of Wisconsin, with Professor A. S. Alexander as head. Professor F. B. Hadley will assist Dr. Alexander in the work. Headquarters for the new department have been provided in the stock pavilion where a dispensary and operating rooms have also been provided. The courses in veterinary science are designed for students of agriculture and enable them to care for animals intelligently both in health and in disease, and to recognize the common diseases, blemishes and vices to which animals are subject.

THE mayor of Brighton, in a circular, quoted in the *London Times*, accompanying his invitation to attend a meeting to consider a proposal to establish a university at Brighton, says that by adopting the scheme suggested by Mr. Clayton, a member of the Education Committee, at the mayoral banquet last month, a university education would be brought within the reach of residents in Sussex who may prefer that their sons should receive university education within reach of their own homes. The Brighton Technical College and the new Training College provide a nucleus around which the scheme could be developed. It is suggested that there might be affiliation with the colleges at Portsmouth and Southampton to constitute a new university for the south coast, or that the present radius of the University of London should be extended to include the proposed new University College.

THE Rev. T. A. BENDRAT, of Turners Falls, Mass., has been appointed instructor in the department of geology at the University of North Carolina, his appointment taking effect on January 4, 1912.

ASSOCIATE PROFESSOR WILLIAM LLOYD EVANS has been made professor of general chemistry in the Ohio State University. The chemical department of the Ohio State University now consists of Professor William McPherson, head of the department, in charge of organic chemistry, and also dean of the Graduate School of Ohio State University; Professor William E. Henderson, professor of inorganic and physical chemistry; Professor Charles W. Foulk, professor of analytical chemistry; Professor William L. Evans, professor of general chemistry; Dr. James R. Withrow, associate professor of chemistry in charge of industrial and applied electro-chemistry; David R. Kellogg, instructor in general and physical chemistry, and Dr. John A. Wilkinson, instructor in analytical chemistry; together with six assistants and nine instructing fellows. There are in addition on the campus in separate buildings the department of agricultural chemistry and the laboratories of metallurg-

ical chemistry, ceramic chemistry and pharmaceutical chemistry, including seven professors, one associate professor, four assistant professors and several instructors.

THE following have resigned their positions in Macdonald College, Province of Quebec: Mr. F. C. Elford, poultry instructor and manager, to take charge of the Educational Bureau of the Cyphers Incubator Co., Buffalo, N. Y.; Mr. J. M. Swaine, lecturer in biology, appointed assistant entomologist of the Dominion Experimental Farms in charge of work on forest insects; Mr. W. H. Brittain, assistant in biology, appointed assistant botanist of the seed division, Dominion Department of Agriculture; Mr. W. B. Cooley, assistant in animal husbandry, to go into private business in British Columbia. The following appointments have been made to the staff of the college: Mr. W. P. Fraser, M.A., Pictou, N. S., lecturer in biology; Mr. W. J. Reid, B.S.A., assistant in animal husbandry.

DR. J. H. BONNEMA, curator of the museum at Delft, has been called to the chair of geology at Groningen, to succeed Professor Van Kolker, who retires from active service.

DISCUSSION AND CORRESPONDENCE

ASTRONOMICAL REFERENCES IN TEXT-BOOKS ON PHYSICS

A SHORT time ago, having occasion to look into the treatment, given in some text-books on physics, of Roemer's method of determining the velocity of light, I was surprised to find a strange lack of information upon some simple definitions and well-known facts of astronomy. Thinking it well to call attention to this matter, I give below quotations from several books.

Glazebrook, "Light" (1894), pages 21 and 22: "Roemer discovered in 1656 that it travels with definite velocity." "... the period between two successive eclipses is known and is found to be 48 hours 28 minutes 35 seconds."

Jones, "Lessons in Heat and Light" (1892), page 197: "It happens that one of Jupiter's satellites (or moons) passes into the shadow of the planet at regular intervals (48½ hours), and is thus eclipsed."

Ames, "Theory of Physics" (1897), page 398: "... when the satellite will disappear behind Jupiter, i. e., be eclipsed."

Watson, "A Text-book of Physics" (1899), page 505: "... when Jupiter and the earth are nearest together (at conjunction), and that which occurs when they are at their greatest distance (opposition)."

Rowland and Ames, "Elements of Physics" (1900), page 172: "... and so, if the eclipses of a satellite behind a planet's disc. . . ."

Eggar, "Wave-motion, Sound, Light" (1901), page 504: "... the times of eclipse of one of the moons, i. e., the instants at which it should pass behind the planet and emerge from his shadow."

Crew, "Elements of Physics" (1906), page 311: "Jupiter has five moons, one of which is larger and brighter than any of the others, and is called the 'first satellite.'" See also "General Physics" (1908), page 429.

Henderson and Woodhull, "Elements of Physics" (1906), page 290: "The eclipse was seen while the earth and Jupiter were on the same side of the sun—as the astronomers say, 'in conjunction'—the time was 16' 36" earlier than when the earth and Jupiter were on opposite sides of the sun; that is 'in opposition.'"

Millikan and Gale, "A First Course in Physics" (1906), page 388: "Roemer was making observations on the largest and brightest of Jupiter's seven moons." "Roemer first determined the interval between two successive eclipses, . . . and found it to be 48 hr. 28 min. and 36 sec."

Gage, as revised by Goodspeed, "Principles of Physics" (1907), page 276: "He made observations on that one of the five of Jupiter's satellites which is nearest to the planet."

Duff (editor), "A Text-book of Physics" (1908), page 339: "... when Jupiter and the earth are in conjunction, or on the same side of the sun and in line with it." "... at opposition, when the earth is on the opposite side of the sun from Jupiter."

Leaving out of consideration the number of Jupiter's satellites at any date, each of the above quotations has one error and some of them two. In many books it is stated that Roemer found the time for the light to cross the earth's orbit to be 16 min. 36 sec. This is nearly the present accepted value, while that

deduced by Roemer was considerably greater, some 22 min.

C. A. CHANT

UNIVERSITY OF TORONTO

AIR IN THE DEPTHS OF THE OCEAN

TO THE EDITOR OF SCIENCE: With reference to the communications appearing in the issues of August 25 and October 27 in relation to "air in the depths of the ocean," while it is erroneous to hold that the amount of dissolved gas is dependent upon hydrostatic pressure, yet the gas content of the bottom waters may be greater than the gas content of the surface waters because of the greater solubility of the gases at the low temperatures prevailing in the depths of the ocean. Sea water contains, in proportions varying widely with circumstances, four gases—oxygen, nitrogen, carbonic acid and argon. The oxygen decreases and the carbonic acid increases with increasing depth; but there is a respiratory process in operation by which the carbonic acid ascends by diffusion right up to the surface, while the oxygen by the same means makes its way to the bottom. This allows us to understand how the supply of oxygen, which is indispensable to the life of the animals everywhere existing in the depths of the ocean, is renewed even down to the bottom and an exchange made between the carbonic acid gas produced by their respiration and the oxygen coming from above.

G. W. LITTLEHALES

CONTAGIOUS ABORTION OF CATTLE

TO THE EDITOR OF SCIENCE: In a recent number (October 13) Director H. L. Russell, of the Wisconsin Agricultural Experiment Station, announces the discovery of the fact that the contagious abortion of cattle in this country is identical with that of Europe, and due to the *B. abortus* of Bang. Professor Russell apparently regards the investigations carried out at the Wisconsin Station since May, 1911, as the first creditable bacteriological work upon this subject in this country, and his communication would seem to cast some doubt upon the accuracy of the observa-

tions and conclusions previously recorded by me.

The experimental evidence concerning the identity of the *B. abortus* isolated at the Illinois Agricultural Experiment Station in 1909 has been presented in several papers,¹ and, in connection with the literature reviewed in the same papers, seems to me to be conclusive. Cultures of the organism have been furnished to several laboratories in various parts of the country. A culture of this bacterium was requested by Professor E. G. Hastings, of the department of bacteriology, Wisconsin Agricultural Experiment Station, in March, 1911, and such a culture was sent to him on April 5, 1911.

W. J. MACNEAL

NEW YORK POST-GRADUATE MEDICAL
SCHOOL AND HOSPITAL

THE MEETINGS OF SCIENTIFIC SOCIETIES

TO THE EDITOR OF SCIENCE: The reasons for isolating the meetings of the American Society of Naturalists, with its two affiliations, the Zoologists and Anatomists, from all other scientific organizations meeting during the Christmas recess seem to be as follows, judging from the chance statements of some of the officers of the societies: (1) Better facilities for delivering papers in the way of apartments, lanterns, etc.; (2) better living accommodations; (3) better chances for the members to become acquainted; (4) isolation from temptations to spread the interests over a wide field. If other reasons have been given, I have not heard them expressed.

Now, of these reasons, the first and second do not seem to me of any validity. A good lantern and comfortable meeting rooms can readily be obtained at any of the centers where

¹MacNeal and Kerr, *Journal of Infectious Diseases*, 1910, Vol. 7, pp. 469-475. MacNeal, Society of American Bacteriologists, Ithaca meeting, 1910. Abstract in *SCIENCE*, 1911, Vol. 33, pp. 548-549; *Centrbl. f. Bakt.*, I. Abt., Ref., 1911, Bd. 49, pp. 390-391. Full paper in *Illinois Agriculturist*, March, 1911, pp. 8-14. MacNeal and Mumford, Illinois Agricultural Experiment Station Bulletin No. 152 (1911, in press).

the larger association meets and in regard to living conditions, I am quite sure that the cities where the American Association for the Advancement of Science meets can offer accommodations equal to those demanded by the most discriminating members of the Naturalists, Zoologists and Anatomists.

With regard to the third reason, I believe that this too, is of minor consideration—not because I do not value the social function of the meetings, for I am under the impression that this factor is paramount. What I mean is that smokers and hotel lobbies and the meetings themselves take care of this element quite well and well enough. If the officers and members who are solicitous in making the meetings a success will present themselves at the various functions rather than seek a quiet corner where they may enjoy the company of a chosen few of their friends to the exclusion of others who would care to meet them, I am quite sure that the third reason will pale into insignificance.

The fourth question seems to me to be the one which is cardinal. I am afraid that it is born of an indifference which certain members have towards any work in zoology or in biology in general which does not have certain relationships. If one will read over the programs of the Zoologists and Anatomists, he will find that papers upon topics of nomenclature, systematics, descriptive zoology and embryology, bionomics and some other subject matter are conspicuously absent from the one and that invertebrate topics are excluded from the other. This means that the rôle of these two societies is not to cover the legitimate field of zoology, but is limited to certain aspects; this is especially true of the Eastern Branch, but less true of the Central Branch of the Zoologists.

In the case of the Naturalists, the limitation of the field is more conspicuous than in the other cases, for here we have an organization which purports to be a nucleus around which the other biological societies are supposed to convene, whose field is more limited than any of the others! I am quite well aware that

there is difference of opinion with regard to the place that genetics holds in the interest of the average zoologist, anatomist, botanist, etc., but the assumption is, on the part of the officers of the Naturalists, that the field is sufficiently broad and fundamental to embrace the interests of men from all fields of biological work. Personally, I am interested in genetics, from the general standpoint, but the minutiae are as technical and demand as close attention as any other field of biological work. The terminology and treatment of the science of genetics are changing daily and unless one take this as his special field of work he finds difficulty in following the discussions. There is another point, too, in this connection: I am not willing to admit that the data of genetics are any more fundamental than the data of other lines of endeavor, as for instance, the subject of development or of differentiation, or of metabolism, or one of a half dozen other things. Genetic development is but one group of phenomena in the ensemble we know as a living thing, even if it is an important one.

It is impossible for the Naturalists to justly solicit membership from botanists, geologists, psychologists, anthropologists and from other departments of science and expect these members to attend the meetings of the Naturalists when this organization meets in cities other than the one in which the special societies are meeting. At least it is not fair to the members of the other societies, who are at the same time members of the Naturalists. If it is the mountain and Mahommed, the mountain will not come to the prophet; of this I am quite sure.

Another point: The field of zoology is so wide and is so intimately connected with many other fields that no one cares to risk his reputation for logical thinking in fixing the limits of this science. Its devotees are not all embryologists, nor students of regeneration, nor of vertebrate anatomy; many of them are interested in animal psychology and others are interested in the physiological aspects of zoology, which stand on the border land be-

tween these sciences and zoology *sensu A.S.Z.* (!) Now meeting at Washington and in affiliation with the American Association for the Advancement of Science are several societies which yearly present papers of direct interest to our members, whose research in comparative psychology or animal behavior causes them to have this interest in the programs of the psychological associations, such as the American Psychological Association and the Southern Society. There are a number of papers presented before the Biochemists and Physiologists which are of interest to other members of the Zoologists and of the Anatomists. Now I wish to submit: Is it fair to these men to demand that they be loyal to the Zoologists and forego the pleasure and profit of attending such meetings in other departments as they desire? Do the reasons given above for isolating the meetings of the zoologists and anatomists compensate for this desideratum? I do not think they do.

It is my impression that there are a number of men whose views coincide with the ones expressed here and this is the *raison d'être* for this communication.

M. W. MORSE

REGARDING PAYING THE EXPENSES OF STATION WORKERS TO SCIENTIFIC MEETINGS

THE American Association of Agricultural Colleges and Experiment Stations at their meeting at Columbus in November passed the recommendation of their Committee on Station Organization and Policy, which reads as follows:

"At the request of one of the societies, with which members of the station's staffs would naturally be associated, the question of members of the staff attending the meetings of the scientific societies was discussed. Your committee believes that the leading members of the staff should, for their own sakes, so far as they are able, attend the sessions of at least one such society annually. It also believes that the station administration should be alive to the fact that there are frequently meetings and conventions at which the best

interests of the station demand that it be represented. In such cases, the proper official should be sent as the station's representative and at its expense."

This was brought to the attention of the committee by the American Association of Economic Entomologists, but of course applies to all divisions of the experiment stations. The details of such arrangements are to be regarded as matters belonging to the administration and they are naturally left to the officers of each institution concerned. The association can not, of course, dictate to directors or boards of trustees; the above is, therefore, to be regarded only in the light of a recommendation showing the sentiment of the association.

F. L. WASHBURN,
*President of the Am. Assoc. of
Economic Entomologists*

SCIENTIFIC BOOKS

Introduction to Psychology. By ROBERT M. YERKES. New York, Henry Holt & Co. 1911. Pp. xii + 427.

The Essentials of Psychology. By W. B. PILLSBURY. New York, The Macmillan Company. 1911. Pp. xi + 362.

An Introduction to Experimental Psychology. By CHARLES S. MYERS. Cambridge, University Press. 1911. Pp. vi + 156.

Elements of Physiological Psychology. By GEORGE TRUMBULL LADD and ROBERT SESSIONS WOODWORTH. (Thoroughly revised and rewritten.) New York, Charles Scribner's Sons. 1911. Pp. xix + 704.

The present year has been an unusually fruitful one in systematic works on psychology. Of the above-noted four text-books in English, three are by Americans. One is an elementary introduction to experimental research, another is a compendium of physiological psychology, and two are general outlines of psychology by writers long known for their special contributions, who have not hitherto given us surveys of the whole science.

The works of Yerkes and Pillsbury form an interesting contrast in standpoint. Professor

Pillsbury, trained in a school which regards introspection as final arbiter, takes a remarkably objective attitude in his book. Psychology is treated as the science of behavior, and the structure and functions of the nervous system receive prominent attention. On the other hand, Professor Yerkes, whose investigations in animal psychology would suggest a predilection for objective criteria, proves to be an out-and-out introspectionist, and omits the customary discussion of the nervous system on the ground that it does not belong in a psychological text-book; nervous structure and animal behavior are merely "signs of consciousness."

Professor Yerkes's book is a capital introduction to scientific psychology. It outlines the fundamental facts, emphasizing the classic "descriptive" psychology, but at the same time seeking to familiarize students with the more important experimental and genetic work. Of its six parts, the first is introductory and discusses the scope and methods of the science; four deal with particular aspects of psychology; while the last part indicates some practical applications.

Part I. examines the relations of psychology to physical science. The data are shown to be substantially the same; but physics and chemistry treat the common material from the objective standpoint, while psychology views it subjectively. It is on the basis of this distinction that the author emphasizes introspection and subordinates behavior to consciousness throughout the work. This part contains an unusually interesting critique of scientific method, well worked out, though possibly too detailed for beginners. In place of the usual terms "observation" and "experiment," the distinction is more logically entitled "naturalistic" and "experimental" observation (p. 45).

Part II. is devoted to descriptive psychology. Professor Yerkes is a champion of the structural psychology, and believes that the first aim of the science is to discover the constitution of consciousness. His account of the

elementary sensations and feelings is well analyzed. He considers sensation and affection distinct classes, since the former possesses "a sort of local mark" which "affection lacks" (p. 147). In discussing the properties attributed by various authors to sensations and affections the writer is remarkably free from bias (pp. 104, 151). He advocates the word "mode" to indicate the fundamental sorts of sensation. Such distinctions as noise and tone are different modes within the same sense. Several tables are given of the senses and their modes (pp. 95-100), and here as elsewhere the tables are excellently presented. The synthetic discussion is good so far as it goes; but unfortunately it stops with perception and imagination. There is no adequate treatment of thought.

In Part IV. Professor Yerkes brings together a remarkable number of psychological generalizations and laws. This portion of the book deserves special study, in view of the claim in various quarters that psychology is not an exact science. The author is at his best here. He notes fifteen laws of sensibility (threshold, contrast, local sign, etc.), three laws of perception, and several laws relating to the affective life, attention and association. The collection and formulation of these laws is a valuable contribution to the science.

Part V. extends these laws to wider generalizations or "explanations" of mental phenomena. The author adopts the parallelistic view, which demands that psychology study psychical events by themselves, before attempting to correlate them with physical happenings. "The essence of the causal relation is uniformity of the order of events" (p. 328). It is found that sensation always precedes the after-image, disagreeable affections are "called up" by sensations, etc. (p. 334). On the very basis, therefore, on which we accept physical causation, these must stand as instances of psychical causation, and we can affirm that "certain mental conditions bring about the formation of an idea, an emotion, a judgment" (p. 336).

Parts II., IV. and V. belong together, and the interpolation of the genetic discussion (Part III.) is a break in continuity. However much the reader may sympathize with the author's desire to introduce genetic notions as early as possible, he will feel that the presentation of this topic should follow Part V. The phylogenetic account, although brief, is clear and thorough, as one would expect from a writer of Professor Yerkes's training and sympathies. Nevertheless, one misses the help which a discussion of behavior at this point would have afforded. This is left till Part V., where the relations of behavior and consciousness are considered in detail. The ontogenetic chapter is somewhat meager. The main stages of mental development from infancy to maturity are examined, but there is no attempt to trace the actual course of individual development. Part VI., on the control of mental life, supplements this chapter. The author points out the relation of psychology to education and eugenics, illustrating the effects of good and bad heredity by the striking contrast between Jonathan Edwards's descendants and the notorious Jukes family.

Failure to examine the thought processes is the only important omission. The cursory treatment of volition and other aspects of the motor life is in logical keeping with the author's purpose to subordinate behavior to consciousness. A novel distinction suggested between lightness and brightness (p. 122) is the only departure from accepted positions which introspection is likely to challenge. The volume shows careful preparation and abounds in good illustrative examples. Excellent judgment is used in the selection of material, and opposing standpoints are presented with remarkable fairness. There are innumerable citations and quotations, especially from recent writers. At the end of each chapter is a class exercise, usually related to the subject matter, which serves as an introduction to experimental methods. The clear style and skillful avoidance of technical expressions make the volume especially suitable for beginners.

Psychologists will welcome Professor Pillsbury's systematic attempt to treat human psychology in terms of behavior. It is unusual for a text-book on psychology to view human activity from an objective standpoint, and it is not easy to retain this point of view consistently.

The author defines psychology as "the science of human behavior" (p. 1). This limitation of the field is open to two objections: (1) it seems to exclude animal behavior from psychology, which is particularly undesirable in an objective discussion; and (2) it apparently discriminates against introspection. The latter criticism, however, is met by a broad use of the term "behavior"; Professor Pillsbury treats mental processes as antecedents of behavior, and includes the usual discussion of sensation, perception, memory, feeling and other phenomena of consciousness.

The structure and functions of the nervous system are thoroughly discussed in two chapters. The real nervous basis of consciousness is found in the synapses. According to this view, habit-formation probably involves a permanent lessening of tension at the synapse, rather than a modification within the neurone. The author seeks to mediate between functional and structural psychology. All psychological facts are reduced to three fundamental principles: "The first is that all mental qualities come originally from sensation. . . . The second principle is that the order in which mental processes of any sort enter consciousness and whether any process does or does not enter consciousness, depends upon the nature of the individual rather than upon the forces in the physical world. . . . The third and last of these principles is that experiences leave a disposition in the nervous system that tends to the reinstatement of that experience on suitable occasion" (p. 153). This provides three elementary facts—sensation, attention and retention—which may be regarded as either elements or processes.

Sensation, according to the author, stands in a specially close relation to the nervous system. "The development of the sense

qualities depends upon and goes hand in hand with the development of the sensory endings. In the simplest organisms there is no differentiation of sensory organs, and consciousness probably shows no differences whatever" (pp. 62-63). The rise of the four skin senses is described first, then the higher senses, finally the kinesthetic, static and organic. The intricate topic of vision is exceedingly condensed, and the author scarcely does justice to the difficulties which have produced rival theories. We find here the paradoxical statement that "the retina is a part of the brain that in the course of development has come to the surface" (p. 86, cf. p. 132).

The chapters on feeling and emotions are very suggestive. The author makes feeling distinct from sensation: "Feelings are subjective, sensations objective" (p. 260). It is not clear how this can be reconciled with the earlier statement that "all mental qualities come originally from sensation" (p. 153). Nor does the position of these chapters furnish a clue; they follow instinct, which comes after perception, memory and reasoning, though the emotions are regarded as "intermediate between feelings and instincts and the higher intellectual operations" (p. 272).

After discussing sensation, attention and retention Professor Pillsbury proceeds to more complex phenomena. The chapter on perception contains a very full account of visual space perception and optical illusions. By some oversight tactual space is omitted. The chapter on memory and imagination contains a very helpful discussion of the laws of learning and the laws of retention and forgetting. On the neural side "learning is the result of producing changes in the synapses, retention depends on the persistence of the impression; forgetting, upon its disappearance" (p. 194). The author is strongly opposed to artificial memory systems, which in his opinion require more effort than they save.

The analysis of intellect and its growth needs amplification. Imagination is treated in about a page, while abstraction is given no independent examination whatever. The dis-

cussion of these processes scarcely affords an adequate basis for the reasoning process. On the other hand, the relation of reasoning to memory and imagination is shown in a particularly striking epigram: "The results of reasoning are new and are accepted as true; the results of memory are true, but not new; and the results of imagination are new, but not true" (p. 217). Professor Pillsbury regards belief as bearing "the same relation to reasoning that recognition does to memory" (*ibid.*).

The student will find the chapter on instinct especially helpful. "Instinct and reflex are to be distinguished in terms of the simplicity of the reflex and the complexity of instinct; by the fact that the reflex can be understood from the mechanical activity of the nervous structures, while the instinct can be referred to its purpose alone; and in the amount of consciousness that attaches to the instinct. . . . In instinct, ordinarily, all is conscious but the reason for the act" (pp. 254-255). The writer distinguishes between individualistic, racial and social instincts, with a suggestive discussion of each.

After the chapters on feeling and emotion the author passes to action and will. Recent work on the acquisition of skill is described; but interest is centered on the control of activity. The writer emphasizes the importance of developing a system of ideals in the individual in order properly to train his will. Work, fatigue and sleep are treated in a single chapter, with an account of the physical effects of fatigue and a curve illustrating depth of sleep.

The two concluding chapters give the broader aspects of the subject. Professor Pillsbury discusses the interrelations of mental functions, with some forcible criticisms of the faculty psychology. "Mind is not a collection of unrelated faculties and . . . it is not a single force or faculty" (p. 341). Experimental research alone can determine whether and how far the training of one function is transferred to another. The author defines three separate aspects of the self, as a contin-

uous existence, as accumulated habits, and as unity of experience.

Dr. Myers's book is precisely what its name implies—an introduction to experimental psychology. It is intended for the beginner and sums up the most representative and interesting results. The presentation is clear and avoids mathematical discussions which are liable to perplex the novice. The whole topic of psychophysics is omitted, and there is no attempt to describe the technique of experimental research. This narrowing of the field is made up for by several features not usually introduced into an experimental text-book. In a number of cases the laboratory data are compared with results obtained from savage races; under the head of cutaneous sensations the author discusses certain pathological conditions which bear on the number of distinct dermal senses; and in describing mental tests stress is laid on the study of individual differences. Considerable of the data on mental tests, esthetics, etc., in this book are not found in the author's larger text-book. All this gives the beginner a wider perspective than if he were confined to the usual laboratory results.

The first chapter sums up the evidence for ascribing several distinct senses to the skin, and can not fail to impress the reader brought up to believe in the traditional five senses. Some of the more striking facts of color vision are discussed in Chapter II. The author alludes (p. 29) to the color terminology in Homer, as indicating a restricted color sense among the ancients. In the next chapter several forms of the Müller-Lyer illusion are illustrated. This and the succeeding topic of esthetics are perhaps treated at disproportionate length; but the chief purpose of the book is to interest the reader in experimental psychology, and one is justified in sacrificing symmetry to this more important aim. The well-known memory experiments are outlined in Chapter V., and the author points out the practical value of knowing how to memorize in the best way.

The last two chapters are devoted to individual tests, including visual acuity, sensory discrimination of various sorts, tests of mental and physical work and fatigue, and association tests. Dr. Myers describes in full the Binet tests, which have recently attracted such attention in this country, and concludes with an explanation of the methods used in correlating different sorts of tests. All his descriptions of tests are very clear, though in one table (p. 98) the value of the standard is inadvertently omitted.

A short bibliography is appended, which seems rather condensed and general for collateral reading. The text will certainly impress the reader with the value of the science, and stimulate him to take up work in the laboratory.

Those of us who were first introduced to physiological psychology through Ladd's "Elements," will be pleased to see that classic work revised and brought thoroughly up to date. Professor Woodworth, who is in close touch with recent neurological research, is associated with Professor Ladd as joint author. The edition in no way yields to the old as an accurate compendium of facts. The length remains about the same. To make way for the wealth of new material much of the old has been condensed. In its new form the book contains a mass of anatomical and physiological facts which every psychologist needs to know—facts which he would otherwise have to gather laboriously from many different sources. To give a single instance: the number of fibers in the dorsal and ventral spinal roots of the frog, and of fibers in the dorsal roots of man, are taken from separate magazine articles which the psychologist would not readily find (p. 75). Authorities are freely cited in footnotes. As in the old edition, the theory of mind and matter is given a prominent place; but the philosophical standpoint never biases the statements of anatomical or physiological fact.

The present work, like the earlier edition, is divided into three parts. The first part, about

300 pages, is devoted to anatomy and general physiology. The second part, slightly longer, embraces what is now known as experimental psychology. It contains an excellent compendium of results from the psychological laboratory, carefully selected and more suitably arranged than even the historic "Grundzüge." The third part, on the "nature of mind," has been considerably shortened. The subject index is unusually good, but the text itself is not easy to consult, for the chapters in each part and sections in each chapter are numbered separately, instead of continuously through the book. Placing the chapter number at the head of the page would have facilitated reference work considerably. Recent terms, such as distance receptor (p. 25) and archi-pallium (p. 31) are used so far as they have been sanctioned, and other new terms, not generally accepted, are mentioned in footnotes; thus, a list is given of the nervous tracts named according to their place of origin and termination (p. 89).

Part I. opens with a new chapter on the evolution of the nervous system from ameba up. The vertebrate and invertebrate types of brain are compared, and an interesting table of brain weight and body weight is copied from Warnecke (p. 34). Chapter II. contains a very explicit account of the development of nervous system and end organs in the human individual, followed by two chapters on grosser and finer nerve structures. The control of each hemisphere over the opposite side of the body is explained with special clearness in the complicated case of vision: "Since the rays of light cross within the eyeball, the right half of each retina receives light from the left side, and therefore the right half of the brain receives the impressions that come from the left side" (p. 92). Another new chapter describes the chemistry of the nervous system, which is seldom brought to the notice of psychologists. This is followed by a discussion of nervous conduction.

Chapter VII. treats of reflex and automatic functions. The authors regard *reflex* as a relative term. "The fatality and predictabil-

ity of reflex action have sometimes been overstated" (p. 173). They hold that the activity of the nervous system in its highest forms is "preeminently *automatic*. It is, therefore, highly probable that the reflex and the automatic forms of its functioning are most frequently, if not uniformly, combined in ever-varying proportions" (p. 149).

Taking up the end organs, a résumé of anatomical investigations indicates that the several cutaneous organs are by no means so definitely identified as psychologists often imagine. The human eye is wittily described in true advertising style as "a wonderfully compact little instrument, capable of being focused on any distance from five inches upward, provided with the only original iris diaphragm, and having the special feature of a self-renewing plate, which automatically alters its sensitivity to suit the illumination, and also gives colored photographs. The camera can not, however, be guaranteed, as some specimens are defective, and even the best are liable to be injured by hard usage; none will be replaced, though some of the defects can be partially corrected'" (p. 196).

Two chapters are devoted to localization of functions in the cerebrum. At the present time, "the 'motor area' is definitely located; the 'visual area' is likewise; and the location of the areas for hearing and smell is only a little less definite" (p. 234). "It is probable that our ordinary movements of the eyes in looking at an object, *i. e.*, in directing the center of clear vision upon it, are reactions through the visual area, and not through the motor area" (p. 249). "Excitation of the temporal lobe, in animals, gives rise to movements of the ears. . . . These are, in appearance, 'listening' movements, and their occurrence indicates that the primary motor adjustment to sound occurs through the auditory area rather than through the motor area" (p. 250). The limitation of the speech functions to the Broca area does not seem justified (p. 259). Unusual emphasis is laid on differences in anatomical structure within the cortex: "The fact that a uniform structure exists

over any considerable area of the cortex, giving place at its borders to areas of other structure, would seem plainly to indicate that within each area the elements have something in common in the manner of their functioning" (p. 273). The authors believe that we need, "on the physiological side, a more detailed knowledge of the structure of the cortex as a whole, and in its different parts; and, on the psychological side, a thorough analysis of such vague and gross so-called functions as 'speech,' or 'skilled movement,' or 'perception of objects,' or 'orientation in space,' into their elementary functional factors" (p. 264).

The concluding chapter of Part I. discusses the mechanism of the nervous system. Preference is given, as in Pillsbury's work, to the synapse or cell-boundary theory, which seems, "when worked out in detail, to be more capable of giving an expression in physico-chemical terms to most of the known peculiarities of central function than any other theory which has been put forward" (p. 290).

The quantitative results of psychophysics, in Part II., are compressed into a single chapter. The authors are inclined to minimize the importance of Fechner's law. "It is not so much . . . a law of absolute quantity of sensations as dependent on stimuli, but rather a law of our apprehension in consciousness of the relation of our own feelings" (pp. 375-6). "Granted that it is no longer considered as giving a measure of sensation; it may be retained as indicating the position of a sensation in the scale of intensities. . . . It seems better, then, to drop Fechner's logarithmic law, and abide by the more empirical expression of Weber" (p. 378).

Two chapters are devoted to sense perception, in which a middle ground is chosen between nativism and empiricism. Visual space perception is examined thoroughly, with considerable stress upon eye movements, though the motor theory is not accepted in its entirety. The survey is confined to space perception; but this limitation does not appear in the definition: "Perception is the result of an extremely complex activity of the psychical

subject, Mind; it involves a synthesis of a number of sense-data according to laws that are not deducible from the nature of the external objects, or of the physiological actions of the end-organs and central organs of sense" (p. 468).

On the affective side, the authors hold to an "almost infinite variety of, not only our complex feelings, emotions and sentiments, but also of those" simpler feelings which have hitherto resisted analysis. Pleasantness and unpleasantness are regarded as merely the "tone" of feeling (p. 515). The esthetic feelings are treated at considerable length, while the moral feelings are only briefly mentioned. The chapter on memory gives the classic results on learning and includes a reference to Freud's new method of psychoanalysis for bringing submerged complexes to the surface (p. 586). The behavior of animals in learning mazes, etc., is described, and curves of human learning and forgetting are reproduced. The mechanism of thought is the subject of the last chapter in this part.

Part III., as in the earlier edition, takes a frankly dualistic attitude. "The two existences, body and mind, may not be identified by the science which investigates their correlations. . . . They are, however, dependently connected. Each stands in causal relations to the other; although this dependence appears to be by no means complete" (p. 653).

One can scarcely overestimate the labor involved in reconstructing such a work as this, written before the neurone theory was formulated, or the evolution of the brain worked out. The revision has been thorough, however, and the "Elements" becomes once more a standard reference-book for the experimental psychologist.

HOWARD C. WARREN

PRINCETON UNIVERSITY

A Text-book of Physiological Chemistry. By OLOF HAMMARSTEN, Emeritus Professor of Medical and Physiological Chemistry in the University of Upsala. Translation from revised seventh German edition by JOHN A. MANDEL, Sc.D., Professor of Chemistry in

the New York University and Bellevue Hospital Medical College. Sixth American edition. New York, John Wiley & Sons. 1911. 8vo. Pp. viii + 964. Cloth, \$4.00 net.

No familiar text-book of physiological chemistry published in recent times presents the interrelations between chemistry and physiology, between organic structure and function, in the effective way that Professor Hammarsten has followed through many editions. To the organic chemist a presentation like that of Röhmann's "Biochemie" may appeal because of its distinctively chemical viewpoint; but to the biologist and physician who are interested above all in the activities of living organisms, the emphasis upon function rather than composition is more acceptable and inspiring.

While others have compiled in cyclopedic handbooks of considerable magnitude the individual chapters of biochemistry prepared by diverse eminent contributors, Professor Hammarsten has continued to retain that comprehensive grasp upon the literature of this subject which has enabled him to condense into a single volume the essential facts of the science. To say that most workers in this field still turn to Hammarsten's "Text-book" as the readiest exponent of both the permanent acquisitions and tentative ideas in chemical physiology, is to pay a just tribute to its author's useful contribution as an educator.

There are signs of the expansion of the details of the science beyond the grasp of one individual. For the first time, a chapter (Physical Chemistry in Biology, by Professor S. G. Hedin, of Upsala) has been prepared by a collaborator. It is a readable presentation of topics—such as osmotic pressure, colloids, catalysis, enzymes, ions and salt action, in their physicochemical bearings—which are not always offered to the untrained appetite in a palatable form.

Without referring in detail to a book of which the essential features must be familiar to many, the reviewer ventures the opinion that the excellent chapter on metabolism is

not as widely appreciated as it deserves to be. There are few comparable or equally comprehensive outlines of the subject published in English. This chapter may serve also to illustrate the effectiveness of the revision which has been practised in the new edition. Not only are new facts introduced (American investigations not being overlooked), but discarded and unsubstantiated views have been conservatively eliminated. For example, there are found detailed allusions to the studies in "artificial" nutrition, Michaud's experiments on the protein minimum, Rubner's recent discussions on nutrition, Murlin's study of gelatin feeding, and the disputed problem of the specific dynamic action of foods. The discussion of obsolete obesity "cures," etc., has been omitted.

In the translator's preface Professor Mandel writes: "The work of translating and editing has been a labor of love, inasmuch as I feel that it will be of aid in the advance of this department of chemical science." He is right, and deserves a renewed expression of appreciation from biochemical workers for the faithful and correct execution of an uninviting task.

LAFAYETTE B. MENDEL

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SPECIAL ARTICLES

ON THE NATURE AND SEAT OF THE ELECTROMOTIVE FORCES MANIFESTED BY LIVING ORGANS¹

1. When an organ of an animal or a plant is injured an electromotive force develops between the injured and the non-injured surface, the latter being, as a rule (if not always), positive to the former. Loeb suggested in 1897 that this difference of potential might be due to the fact that the injured spot formed an acid and that on account of the H-ion moving faster than the anion a difference of potential was produced. This assumption accounted for the sense of the E.M.F. in a partially injured organ. It was, however, pointed out that the order of magnitude of such dif-

¹ Preliminary communication.

fusion elements is too small to account for the E.M.F. found in living organs. Wilhelm Ostwald had suggested the possibility that living organs form concentration elements with a solid phase interposed, the solid phase—the membrane—being permeable for certain ions only. Bernstein starting from Helmholtz's conception of free energy conceived the idea that measurements of the effect of temperature on the E.M.F. of a partially injured muscle or nerve might indicate the nature of the elements to which these systems belong. He reached the conclusion that the partially injured muscle belongs to the type of concentration element in which a solid phase—the membrane—separates the two liquids, the solid phase being only or more permeable to kations than to anions, thus corroborating Ostwald's suggestion.

Bernstein found that the E.M.F. of the muscle rises in general with the temperature and that it approaches a value in proportion to the temperature. The agreement was, however, not as good as should be desired to put the theory of concentration cell of the muscle current on an absolutely safe basis. Moreover, experiments on nerve were less satisfactory and in both cases accessory assumptions were required to make the actual results agree with the theory.

2. Muscles and nerves are, perhaps, too variable or rather perishable to investigate quantitatively with any degree of satisfaction the nature and origin of their E.M.F. We selected for this purpose a hardier and more constant object, namely, apples, the surface film of which is strong and which remains sufficiently constant during such an investigation. Instead of testing the effect of temperature on the E.M.F., we selected the effect of the concentration of the solutions in contact with the apple. The limit within which the temperature can be safely changed without injuring or modifying the living organ is very small and this is one of the reasons why Bernstein's figures are not quite satisfactory, as he himself recognized; while we can change the concentration on such living ob-

jects as the apple in very wide limits without injury or complicating alterations.

We found the following method most satisfactory. An apple with perfect skin was put into a glass dish containing a small amount of a liquid *a*. On the opposite side of the apple a piece of the skin and the underlying tissue was removed and into the hole was put a small quantity of a liquid *b*. The latter remained constant throughout the experiment, while *a* was changed according to the nature of the experiment. Both liquids *a* and *b* were connected with calomel electrodes and the E.M.F. was determined by Poggendorf's compensation method (capillary electrometer). The temperature was kept practically constant (about 19° C.).

We, therefore, were studying the E.M.F. of the following system: liquid *a*; apple; liquid *b*, the membrane of the apple being the solid phase between liquids *a* and *b*. According to the theory a fivefold dilution of *a* should always give a constant decrease of E.M.F., namely, .040 volt; and a tenfold dilution should decrease the E.M.F. always by a value of .058 volt. These values may be expected to be smaller if the ideal conditions of semi-permeability are not fulfilled.

In the following experiment liquid *b* (in the apple) was *m*/10 KCl. Liquid *a*, on external surface, varied in concentration. The calomel electrodes contained *m*/10 KCl. The

E.M.F. by .035 volt; from *m*/250 to *m*/1,250 by .034 volt; from *m*/1,250 to *m*/6,250 by 0.32 volt. By diluting from *m*/10 to *m*/50 we find .028 volt, which is a little too small. We have found it to be generally true that as soon as we work with more concentrated solution than *m*/50 the differences are a little smaller than the theory demands. Whether this is due to the decrease in ionization or to an injurious effect of the solutions of higher concentration upon the skin of the apple we are not yet prepared to state.

The values observed are all a little smaller than we should expect. According to Nernst's formula the difference of potential for a dilution of five should be .040 volt, while we found a difference of .033 volt. The fact that we did not get the maximum potential difference is, perhaps, due to the fact that the skin of the apple is not completely impermeable for anions.

Experiments with other salts gave similar results as far as the effect of concentration was concerned.

3. The sign of the E.M.F. of the system electrolyte; apple; electrolyte was always in that sense as if the membrane of the apple were more permeable for kations than for anions. In order to test this possibility the electromotive effects of NaCl were compared with those of Na₂SO₄. If our assumption were correct the E.M.F. of a NaCl solution should always be equal to the E.M.F. of a Na₂SO₄ of half the concentration of the former. The following example shows that this is actually the case. The internal liquid *b* remained constant throughout the experiment *m*/10 KCl. The external liquid *a* varied according to Table II.

TABLE I

Concentration of Liquid <i>a</i> .	E.M.F.
<i>m</i> /10 KCl	+ .040 volt
<i>m</i> /50 KCl	+ .068 volt
<i>m</i> /250 KCl	+ .103 volt
<i>m</i> /1,250 KCl	+ .137 volt
<i>m</i> /6,250 KCl	+ .169 volt

sign + means that liquid *a* was positive to liquid *b*. In this experiment each successive liquid was five times as diluted as the previous one and the theory demands that the difference of E.M.F. between two successive solutions should be identical. If we compare the interval from *m*/50 to *m*/6,250 this is true. A dilution from *m*/50 to *m*/250 increases the

TABLE II

Liquid <i>a</i> .	E.M.F.
<i>m</i> /10 NaCl	+ .038 volt
<i>m</i> /100 NaCl	+ .090 volt
<i>m</i> /1,000 NaCl	+ .139 volt
<i>m</i> /2,000 Na ₂ SO ₄	+ .141 volt
<i>m</i> /200 Na ₂ SO ₄	+ .092 volt
<i>m</i> /20 Na ₂ SO ₄	+ .044 volt

This experiment shows that whether the anion is Cl or SO₄ as long as the concentra-

tion of the kation remains the same the E.M.F. remains unaltered. The E.M.F., if liquid *a* is $m/1,000$ NaCl, is .139 volt, and if it is $m/2,000$ Na_2SO_4 is .141 volt; practically identical values. If the liquid *a* is $m/100$ NaCl it is .090 volt, if it is $m/200$ Na_2SO_4 it is .092 volt; again practically identical values.

4. It was necessary to convince ourselves that we were not dealing with purely osmotic effects (and possibly diaphragm currents). In one experiment the external liquid *a* was $m/100$ NaCl, the liquid *b* on the injured side of the apple was $m/10$ KCl. The E.M.F. was +.092 volt. Then enough cane sugar in crystals was added to the liquid *a* to make its total concentration about $m/2$. After the sugar was dissolved the E.M.F. was .093 and remained so. Changes in concentration by a non-electrolyte like cane sugar, therefore, do not alter the E.M.F.

5. Continuing an investigation by Haber and Beutner on "Phasengrenzkräfte," Haber and Klemensiewicz described a concentration cell for H-ions of the type, acid; glass; alkali, the acid representing the solution with a high, the alkali with a low concentration of H-ions. Haber pointed out that this type of concentration element might correspond to the type represented by muscle, the muscle fibrils corresponding to the glass in the acid alkali element. Since the liquids in the cells are practically neutral a slight production of acid in the fibril (or the injured spot) would give rise to a considerable E.M.F. We fully expected at the beginning of these experiments to find that the E.M.F. of living organs was of the type of that found by Haber. We found, however, that for the apple this is not the case, as the following experiment shows. The internal liquid *b* was throughout the whole experiment $m/10$ KCl (neutral). The external liquid *a* was in succession $m/20$ NaCl, neutral, alkaline, acid and alkali again. It was rendered acid through addition of enough HCl to render the $m/20$ NaCl solution $m/1,000$ acid, and it was rendered alkaline through the addition of enough NaHO to render the $m/20$ NaCl solution $m/1,000$ alkaline.

TABLE III

Liquid <i>a</i> .	E.M.F.
$m/20$ NaCl, neutral	+ .051 volt
$m/20$ NaCl, $m/1,000$ alkaline	+ .052 volt
$m/20$ NaCl, $m/1,000$ acid ..	+ .048 volt
$m/20$ NaCl, $m/1,000$ alkaline	+ .052 volt

The differences found between neutral, acid and alkaline $m/20$ NaCl are slight and within the limits of purely accidental variations. If we were dealing with a reversible cell in regard to H-ions we should expect a difference of almost .5 volt between $m/1,000$ acid and $m/1,000$ alkali.

6. It may be of interest to mention also that acids and alkalis behave in regard to the E.M.F. to which they give rise like the salts. The experiments we made in this respect show also that if the concentrations of these substances are a little too high the regularity of the results suffers, and the irregularities are always of such a nature as should be expected if the injury or the etching effect of acids and alkalis increased the anion permeability of the skin of the apple. Liquid *b* in the apple was $m/10$ NaCl throughout the experiment.

TABLE IV

Liquid <i>a</i> .	E.M.F.
$m/10$ NaCl	+ .003 volt
$m/10$ NaHO	+ .009 volt
$m/100$ NaHO	+ .041 volt
$m/1,000$ NaHO	+ .085 volt
$m/10,000$ NaHO	+ .125 volt
$m/100$ NaHO	+ .042 volt
$m/1,000$ NaHO	+ .085 volt
$m/100$ NaHO	+ .044 volt
$m/10,000$ HCl	+ .126 volt
$m/1,000$ HCl	+ .064 volt
$m/100$ HCl	+ .021 volt

The $m/10$ NaHO and the $m/100$ HCl act as if they had a slight etching effect on the skin, otherwise we notice the same influence of dilution as in the case of salts.

7. We believe that these and other experiments, which will be published in the full report, show that the influence of the concentration of electrolytes on the E.M.F. of living organs agrees quantitatively with the values to be expected if the skin is permeable for

kations, impermeable or less permeable for anions.

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THE PERMEABILITY OF THE OVARIAN EGG-MEMBRANES OF THE FOWL

I

VERY ordinary eggs have long been the subject of very much noise-making; the cackling hen, the cold-storage man, and the public each playing in this an individual, different and discordant part. One wonders therefore whether the quiet of the earth might be in any measure restored if *ordinary* eggs were made different; particularly if the egg were so much metamorphosed as to be born in a fully preserved and stable state. Would the noisily expressed solicitude of the persevering egg-maker then abate? Would the cold-storage man then "fold his tent like the Arabs, and as silently steal away"? Would the voiceful public then wait with less impatience "for its ships to come from sea"?

With something of this thought—of possibly contributing a modicum to the quiet of our planet—the undersigned, in an odd moment, set to the present task many months ago. Despite the generally rough exterior of the common barn-yard fowl, is it not possible to bring about some very nice adjustments between its blood and its growing ova, such as will effect the formation of eggs thus capable of maintaining themselves against the ravages of time and the decomposing influences of temperature?

To some veteran doubters, however, it may seem that the triumph of the experiment would bring no blessings whatever; and some there may be who would even assert that its success and utilization really but spells new calamity to egg-users. We do not know; we repose in our innocent intentions, in our wonder, and in our questions.

II

Can hexamethylentetramine leave the blood and penetrate the cells which guard the germ

—the germ-plasm? Supposing that it can do so, will this substance decompose spontaneously within the egg—as it is known to do in some tissues—setting free formaldehyde? And will not the formaldehyde thus liberated exercise a preserving action on the elements of the egg? Again, can sodium benzoate pass through the egg-envelopes and enter the growing egg? If so, will it do duty as a preservative there? What will sodium salicylate do in a similar way?

The answer to these questions in so far as it is supplied by our experiments may be given at once; the details and the evidence being presented later.

When hexamethylentetramine (urotropin) is fed to laying hens it passes through the follicular and vitelline membranes surrounding the egg and is deposited in the egg. It undergoes decomposition there; formalin being set free. It acts as a preservative; *i. e.*, it lengthens the time which normally intervenes between the fresh and the unpalatable egg.

Numerous chemical tests have failed to demonstrate the presence of either benzoate or salicylate in eggs from birds fed with these substances. Whether the latter actually entered the egg, but in another form or combination, *e. g.*, as hippuric and salicyluric acids respectively, has not been determined; our supply of eggs having been exhausted in making other tests. Quite probably the benzoate would give rise to ornithuric acid, since it is known that this acid is formed when benzoate is excreted through the kidneys of birds. Some other evidence, however, is afforded by the eggs from birds fed with sodium benzoate and sodium salicylate that such eggs, particularly those supposed to contain salicylate, withstand the effects of summer temperatures better than do the untreated control eggs.

III

Something is intimated above as to reasons for the expectation that the feeding of urotropin to birds would result in its penetration and preservation of the growing egg. A

further word of similar effect may be stated concerning the benzoate and the salicylate. It seemed reasonable to expect that these substances would enter the egg, not only because there is a pronounced tendency of ring- and other compounds to appear in the egg, as my own previous, though unpublished, studies have taught me, but because it was known that these substances are normally not broken down, *i. e.*, not completely oxidized in the body, and even appear in other secretions than the urine; benzoic acid, for example, having been recovered from the saliva of dogs; and the salicylate likewise from milk, perspiration, bile and from synovial sacs.

If these substances should appear in the egg it seemed reasonable to expect them to exercise a preserving action there, since it is known that they retard both peptic and tryptic digestion; putrefaction of protein solutions being retarded or entirely prevented by the presence, even in small quantities, of these compounds.

The experiments were carried out in the following manner: Normally fed, laying hens were arranged in lots of five each. To one lot urotropin was fed; to another sodium benzoate, and to another sodium salicylate. The feedings were continued over a period of eight to ten days. All of the eggs laid during the week preceding the beginning of the dosing period, and all laid during the *second* week after the close of that period, were kept as control (those laid during the first week after the dosing stopped were discarded as being contaminated with the drug).

The dosage in each case was 0.4 G. administered in gelatin capsules twice per day; *i. e.*, the total dosage during each twenty-four hours was four-fifths of a gram. Two birds were not in good condition on the fifth day of the dosing and were withdrawn from the experiment.

Both control and dosed eggs were kept at moderate temperatures, *i. e.*, 12°–18° C., until the last of the control eggs were laid. Then all were placed at a temperature which fluctuated from 20°–32° C.; being left thus exposed

for months in order to compare the "keeping" qualities of the various eggs.

It is probably best to follow more specifically the eggs from the birds which were fed urotropin, since in these the experiment was the most successful. The eggs of the series were laid between June 30 and July 30. They belong, therefore, to the class of difficult-to-keep, summer eggs which cold-storage men designate as "dirties." Already on August 20 and on September 17 a comparison by taste and smell of control and dosed eggs left no doubt whatever that the dosed eggs were the more palatable. These tests repeated on October 12 and November 10 confirmed the earlier result. On the latter dates the control eggs almost without exception were quite unpalatable. The dosed eggs could be eaten even on the last named date. It can not be said, however, that these control eggs would ever be mistaken for really fresh eggs; nor that the consistency of the white or albumen was quite unchanged, for after a time the albumen of some of these eggs becomes rather more dense and elastic than is natural.

When tested for formaldehyde, by the Rimini and other tests, the eggs of this series yielded abundant quantities. Indeed it was found that such eggs were spontaneously giving off formaldehyde in quantities sufficient to be absorbed by, and detected in, some *control* eggs left in the same box. To my friend Professor Hugh McGuigan, of the Northwestern University Medical School, who is extensively studying the action and disposition of hexamethylenetetramine in mammals, I am indebted for verifying these tests as well as for friendly and helpful conversations and suggestions.

It was made certain that the urotropin is excreted into both the white and the yolk of the egg. This was determined in the following manner: Eggs which were laid within twenty-four hours of a *first* feeding with urotropin were found to yield formaldehyde. Here the formaldehyde could not have entered the *yolk* while in the ovary, since such yolk must have left the ovary several hours before the feeding. It must, therefore, have

been excreted by the oviduct into, or with, the albumen. In the other case it was shown that urotropin can penetrate the follicular membrane and enter directly into the egg-yolk, since an egg which was laid five days after the *last* feeding with urotropin gave the test for formaldehyde. Two other eggs were laid by the same hen—two and four days previously—so that the above-mentioned egg could not have obtained its formalin from albumen stored in the oviduct. In this egg, therefore, only the yolk had been exposed to urotropin, and it only could have been the source of the formalin. Two other eggs of very similar history also gave positive tests for the presence of formalin in the yolk.

The eggs dosed with salicylate,¹ and less markedly those dosed with benzoate, besides appearing—somewhat inconstantly—to be better preserved, as judged by taste and smell, often showed certain other physical contrasts with the control eggs. For example, the yolks of the control eggs more often showed “adhesions” to the shell than did the dosed eggs. Of fifteen control eggs opened on October 12 and November 10, nine showed adhesions either to shell or to the membrane of the air cavity; whereas on the same dates ten eggs dosed with salicylate and eight dosed with benzoate furnished altogether only three adhesions. Too, the control eggs usually contained the more liquid albumen; a difference readily observed. Finally, it was often noted that there was present in the dosed eggs more of the dense whitish albumen of the chalazæ than in the control.

Obviously all these physical differences strengthen the not very conclusive evidence of taste and smell, that the eggs dosed with salicylate and benzoate had not undergone digestion and putrefaction to as great an extent as the normal untreated eggs.

Larger doses of these substances would probably yield more striking results. Doses of 0.2 G. of sodium benzoate were, however, occasionally seen to be regurgitated by pigeons.

¹I am indebted to Mr. Valentine Petzold, an obliging poultryman of Chicago, for the privilege of dosing five of his birds with sodium salicylate.

I do not believe that any part of either of these drugs was so disposed of by the fowls. Actively laying hens—as these were—might withstand considerably larger amounts. Too, still other substances can doubtless be found which will yield as good or better results when applied by this method. But these questions and others are left to the labor of those who may be interested in the practical or economic possibilities of the matter.

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THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

THE American Association for the Advancement of Science and the national scientific societies named below will meet at Washington, D. C., during convocation week, beginning on December 27, 1911.

American Association for the Advancement of Science.—President, Professor Charles E. Bessey, University of Nebraska; retiring president, Professor A. A. Michelson, University of Chicago; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.

Section A—Mathematics and Astronomy.—Vice-president, Professor Edwin B. Frost, Yerkes Observatory; secretary, Professor George A. Miller, University of Illinois, Urbana, Ill.

Section B—Physics.—Vice-president, Professor Robert A. Millikan, University of Chicago; secretary, Professor A. D. Cole, Ohio State University, Columbus, Ohio.

Section C—Chemistry.—Vice-president, Frank K. Cameron, U. S. Department of Agriculture; secretary, Professor C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D—Mechanical Science and Engineering.—Vice-president, President Chas. S. Howe, Case School of Applied Science; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E—Geology and Geography.—Vice-president, Professor Bohumil Shimek, State University of Iowa; secretary, Dr. F. P. Gulliver, Norwich, Conn.

Section F—Zoology.—Vice-president, Professor Henry F. Nachtrieb, University of Michigan; sec-

retary, Professor Maurice A. Bigelow, Teachers College, Columbia University, New York City.

Section G—Botany.—Vice-president, Professor Frederick C. Newcombe, University of Michigan; secretary, Professor Henry G. Cowles, University of Chicago, Chicago, Ill.

Section H—Anthropology and Psychology.—Vice-president, Professor George T. Ladd, Yale University; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor William T. Porter, Harvard Medical School; secretary, Professor George T. Kemp, 8 West 25th St., Baltimore, Md.

Section I—Social and Economic Science.—Vice-president, Professor J. Pease Norton, Yale University; secretary, Seymour C. Loomis, 69 Church St., New Haven, Conn.

Section L—Education.—Vice-president, Professor Edward L. Thorndike, Teachers College, Columbia University; secretary, Professor C. R. Borgmann, University of Chicago, Chicago, Ill.

The Astronomical and Astrophysical Society of America.—December 27–29. President, Professor E. C. Pickering, Harvard College Observatory; secretary, Professor W. J. Hussey, University of Michigan, Ann Arbor, Mich.

The American Federation of Teachers of the Mathematical and the Natural Sciences.—December 27–28. President, Professor C. R. Mann, University of Chicago; secretary, Eugene Randolph Smith, Polytechnic Preparatory School, Brooklyn, N. Y.

The American Chemical Society.—December 27–30. President, Professor Alexander Smith, Columbia University; secretary, Professor Charles L. Parsons, Durham, N. H.

The American Society of Biological Chemists.—(Baltimore and Washington.) December 27–29. President, Professor Lafayette B. Mendel, Yale University; secretary, Professor A. N. Richards, University of Pennsylvania, Philadelphia, Pa.

The Society of American Bacteriologists.—December 27–29. President, Professor F. P. Gorham, Brown University; secretary, Charles E. Marshall, East Lansing, Mich.

The American Physiological Society.—(Baltimore and Washington.) December 26–29. President, Dr. S. J. Meltzer, Rockefeller Institute for Medical Research, New York City; secretary, Professor A. J. Carlson, University of Chicago, Chicago, Ill.

The Geological Society of America.—December

27–29. President, Professor William Morris Davis, Harvard University; secretary, Dr. Edmund Otis Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—December 28–30. President, Professor Ralph S. Tarr, Cornell University; secretary, Professor Albert Perry Brigham, Hamilton, N. Y.

The Paleontological Society.—December 28–30. President, Professor William B. Scott, Princeton University; secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

The Entomological Society of America.—December 26–27. President, Professor Herbert Osborn, Ohio State University; secretary, Professor Alexander D. MacGillivray, University of Illinois, Urbana, Ill.

The American Association of Economic Entomologists.—December 27–29. President, Professor F. L. Washburn, St. Anthony Park, Minn.; secretary, A. F. Burgess, Melrose Highlands, Mass.

The American Microscopical Society.—December 29. President, Dr. A. E. Hertzler, 402 Argyle Building, Kansas City, Mo.; secretary, T. W. Galloway, Decatur, Ill.

The Botanical Society of America.—December 26–29. President, Professor William G. Farlow, Harvard University; secretary, Dr. George T. Moore, Botanical Garden, St. Louis, Mo.

The Society for Horticultural Science.—December 29. President, Professor S. A. Beach, Ames, Ia.; secretary, C. P. Close, College Park, Md.

The American Phytopathological Society.—December 27–29. President, Professor A. D. Selby, Wooster, Ohio; secretary, Dr. C. L. Shear, Department of Agriculture, Washington, D. C.

The American Nature-Study Society.—December 27–28. President, Professor Benjamin M. Davis, Miami University; secretary, Dr. Elliot R. Downing, University of Chicago, Chicago, Ill.

The Sullivant Moss Society.—December 28. President, Dr. Alexander W. Evans, Yale University; secretary, Mrs. Annie Morrill Smith, 78 Orange Street, Brooklyn, N. Y.

The American Fern Society.—December 29. President, Dr. Philip Dowell, Port Richmond, N. Y.; secretary, L. S. Hopkins, Peabody High School, Pittsburgh, Pa.

The American Anthropological Association.—December 27–30. President, Dr. J. Walter Fewkes, Bureau of Ethnology; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-Lore Society.—December 28. President, Professor Henry M. Belden, University of Missouri, Columbia, Mo.; secretary, Dr. Charles Peabody, Peabody Museum, Cambridge, Mass.

The American Psychological Association.—December 27-29. President, Professor Carl E. Seashore, University of Iowa; secretary, W. Van Dyke Bingham, Dartmouth College, Hanover, N. H.

The Southern Society for Philosophy and Psychology.—December 28-29. President Dr. S. I. Franz, Government Hospital for the Insane, Washington, D. C.; secretary, Professor R. M. Ogden, University of Tennessee, Knoxville, Tenn.

The American Economic Association.—December 27-30. President, Professor Henry W. Farnham, Yale University; secretary, Professor T. N. Carver, Harvard University, Cambridge, Mass.

The American Statistical Association.—December 27-30. President, Frederick L. Hoffman, Newark, N. J.; secretary, Carroll W. Doten, 491 Boylston Street, Boston, Mass.

The American Sociological Society.—December 27-30. President, Professor Franklin H. Giddings, Columbia University; secretary, Professor A. A. Tenney, Columbia University, New York City.

The American Civic Alliance.—December 29. President, Dr. John Franklin Crowell, 44 Broad St., New York City; secretary, Dr. Gerald van Casteel, 80 Wall St., New York City.

The American Association for Labor Legislation.—December 28-30. President, Professor Henry R. Seager, Columbia University; secretary, Dr. John B. Andrews, Metropolitan Tower, New York City.

The American Home Economics Association.—December 27-30. President, Miss Isabel Bevier, University of Illinois; secretary, Benjamin R. Andrews, Teachers College, Columbia University, New York City.

PRINCETON, N. J.

The American Society of Naturalists.—December 28. President, Professor H. S. Jennings, The Johns Hopkins University; secretary, Professor Charles R. Stockard, Cornell Medical School, New York City.

The American Society of Zoologists.—December 27-29. President, Professor H. V. Wilson, University of North Carolina; secretary, Dr. Raymond Pearl, Maine Agricultural Experiment Station, Orono, Me.

The Association of American Anatomists.—De-

cember 27-29. President, Professor George A. Piersol, University of Pennsylvania; secretary, Professor G. Carl Huber, 1330 Hill Street, Ann Arbor, Mich.

NEW YORK CITY

The American Mathematical Society.—December 27-28. President, Professor H. B. Fine, Princeton University; secretary, Professor F. N. Cole, 501 West 116th Street, New York City.

SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES SECTION OF BIOLOGY

A REGULAR meeting of the Section of Biology was held at the American Museum of Natural History, October 16, 1911, Chairman Frederic A. Lucas presiding. The program consisted of a lecture by Dr. Charles H. Townsend, director of the New York Aquarium, on "The Voyage of the *Albatross* to the Gulf of California."

In the spring of 1911 the *Albatross*, under the direction of Dr. Townsend, made a natural history survey of the Gulf of California. Much valuable information was obtained bearing on the oceanography and the general biology of this region, and especially the deep-sea forms.

After stating that the American Museum of Natural History, the New York Zoological Society, the New York Botanic Museum and the United States National Museum cooperated in the voyage of the *Albatross* by special arrangement with the U. S. Bureau of Fisheries, Dr. Townsend gave a general account of the work done.

The *Albatross* sailed from San Diego. Twenty-six hauls of the dredge were made, the deepest being 1,760 fathoms. Shore work was carried on at 32 anchorages around the peninsula of Lower California and at islands in the gulf. Important collections of mammals, birds, reptiles and plants were made. A special study was made of the fishery resources of the region. An interesting feature of the expedition was the rediscovery of the supposed extinct elephant seal (*Mirounga*). About 100 of these animals were found at Guadeloupe Island, which is uninhabited. Six yearlings were sent alive to the New York Aquarium, and three large males and a female were secured for skins and skeletons. The males were each 16 feet long. Excellent photographs were made. Among the interesting forms obtained by dredging were *Harriotta* and *Cyema*, two deep-sea fishes not previously recorded from the Pacific.

At the regular monthly meeting of the section held at the American Museum of Natural History, November 13, 1911, Chairman Frederic A. Lucas presiding, the following papers were read:

Further Notes on the Evolution of Paired Fins:

W. K. GREGORY.

The problem under consideration is a phase of vertebrate phylogeny and should be studied in connection with this larger problem.

In very early acquiring myotomes the ancestral vertebrates gained a means of locomotion, by lateral flexures of the body, that was more efficient than movement by means of ciliated epidermis.

The earliest vertebrates probably fed on microscopic particles obtained by ciliary ingestion. The Upper Silurian *Birkenia* of Traquair apparently had no biting jaws and may have sucked in small food particles, like the larval lamprey. Well-preserved material showed that none of the Ostracoderms had cartilage jaws or teeth, but the dermal plaques around the oral hood sometimes functioned as jaws. Typically carnivorous habits, involving true cartilage jaws, true teeth and both paired and median fins, are first known in the Acanthodian sharks, of the Upper Silurian and Devonian. In brief, fins of all kinds, conditioned in their first appearance by the presence of myotomes, were evolved as an incident in the general transformation of acraniate minute forms, with ciliary ingestion, into well-cephalized fishes of carnivorous habits. The speaker reviewed the evidence for the "fin-fold" theory in the different groups and stated some apparently new objections to the "gill arch" theory. He cited evidence tending to show that the various paddle-like types of paired fins with widely protruded basal cartilages, had evolved from fin-folds independently in the sharks, Crossopterygians and Dipnoans.

Notes on a Pheasant Expedition to Asia: C. WILLIAM BEEBE.

Mr. Beebe gave a short talk, illustrated with lantern slides, on the recent trip which he and Mrs. Beebe made around the world in search of material for a monograph of the Phasianidae. This expedition was made under the auspices of the New York Zoological Society and at the suggestion and by the financial support of Col. Anthony R. Kuser. In the short time at his disposal he was able to touch only upon Ceylon and the Himalayas. In Ceylon the jungle-fowl peculiar to the island and the India peafowl were studied and their nests and eggs found, and in the Himalayas every genus of pheasant was in-

vestigated, from *Gennæus melanonotus* at six thousand feet, to *Ithaginis cruentus* at an elevation of fourteen thousand feet.

The three most important points brought out were the tremendous economic importance of this group, our ignorance of their ecology, and the rapidity of their extermination.

The following nominations were made for officers of the Section of Biology for 1912:

Vice-president of the New York Academy of Sciences, and chairman of the section, Dr. Frederic A. Lucas (renominate).

Secretary of the section, Dr. William K. Gregory, American Museum of Natural History.

L. HUSSAKOF,
Secretary

AMERICAN MUSEUM OF NATURAL HISTORY

THE TORREY BOTANICAL CLUB

THE meeting of October 25, 1911, was held in the museum building of the New York Botanical Garden at 3:30 P.M., Vice-president Barnhart presiding.

The scientific program consisted of informal reports on the summer's work. Dr. N. L. Britton discussed the genus *Cameraria* L. and illustrated his remarks by specimens and illustrations of the known species, together with those of an undescribed one found by him at the United States Naval Station, Guantanamo, Cuba. He also remarked on the large number of undescribed species of plants in many genera contained in the recent Cuban collections of the New York Botanical Garden.

Dr. Marshall A. Howe gave a brief résumé of a paper on "Some Marine Algæ of Lower California, Mexico," which had been accepted for publication in the November number of the *Bulletin*. The algæ of Lower California have been hitherto almost unknown, only seven species having been attributed to the region. The materials on which the present paper was based give evidence of the existence there of at least thirty-four species, a good proportion of them being new to science, and it seems probable that adequate exploration of the region would show its algal flora to be rich and varied.

Dr. J. K. Small gave some brief notes on certain species of *Peperomia*, and Dr. H. M. Richards outlined some research work on acidity in cacti, which he had been prosecuting at the Desert Laboratory, Tucson, Arizona.

FRED J. SEAVER,
Secretary pro tem.